U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB-297 051

Lehigh River Intensive

(U.S.) Environmental Protection Agency, Annapolis, MD

Mar 79

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 903/9-79-004	2.
3. RECIPIENT'S ACCESSION NO. PB297051	
4. TITLE AND SUBTITLE: Lehigh River Intensive	5. REPORT DATE: March 1979
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S): Daniel K. Donnelly, Joseph L. Slayton, E. Ramona Trovato	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Environmental Protection Agency, Annapolis Field Office, Region III, Annapolis Science Center, Annapolis, Maryland 21401	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS: Same	13. TYPE OF REPORT AND PERIOD COVERED
	14. SPONSORING AGENCY CODE: EPA/903/00

15. SUPPLEMENTARY NOTES

16. ABSTRACT

An intensive survey of the lower reach of the Lehigh River between Palmerton and the mouth was conducted during October 1977. The study included the water quality, hydrologic and benthic characterizations necessary for calibration and verification of a mathematical model being developed by the EPA Region III Water Planning Branch.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
dissolved oxygen Biochemical Oxygen demand Nitrogenous Oxygen demand Sediment Oxygen demand metals concentration nutrient concentration	diurnal fluctuations stream gaging time of travel sediment analysis water analysis	

18. DISTRIBUTION STATEMENT: Release to public	19. SECURITY CLASS *(This Report)*: unclassified	21. NO. OF PAGES: 112
	20. SECURITY CLASS *(This page)*: unclassified	22. PRICE: PC A06 / MF A01

EPA Form 2220-1 (9-73)

PB 297051

U.S. ENVIRONMENTAL PROTECTION AGENCY

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

MIDDLE ATLANTIC REGION-III 6th and Walnut Streets, Philadelphia, Pennsylvania 19106

EPA 903/9-79-004

LEHIGH RIVER INTENSIVE*

March 1979

Annapolis Field Office

Region III

Environmental Protection Agency

*This was a joint study conducted by the Annapolis Field Office and the Pennsylvania Department of Environmental Resources

EPA 903/9-79-004

Annapolis Field Office
Region III
Environmental Protection Agency

Lehigh River Intensive

March 1979

Daniel K. Donnelly
Joseph L. Slayton
E. Ramona Trovato

Annapolis Field Office Staff

John Austin
James Barron
Robert Ambrose
Robert Bubeck
Leo Clark
Gerry Crutchley
Ann Donaldson
Gerry Donovan
Bettina Fletcher
Norman Fritsche
Marilyn Gower
Victor Guide
George Houghton
Patricia Johnson
Ronald Jones
Rosemary Kayser
Donald Lear
Tangie Lindsey
James Marks
Margaret Mason
Ruth Ann McGuire
Evelyn McPherson
Margaret Munro
Thomas Munson
Maria O'Malley
Thomas Pheiffer
Janet Roberson
Susan Smith
Earl Staton
William Thomas
Robert Vallandingham
Orterio Villa

Disclaimer

The mention of trade names or commercial products in this report is for illustration purposes and does not constitute endorsement or recommendation by the U.S. Environmental Protection Agency.

Table of Contents

		Page
I.	Purpose and Scope	1
II.	Study Description	2
	A. Stream Sampling	3
	B. Effluent Sampling	3
	C. Long Term BOD Experiment	3
	D. Diurnal Study	7
	E. Flow Measurement	7
	F. Time of Travel	9
	G. Benthic Characterization	9
III.	Field Procedures	9
	A. Sample Collection	9
	B. Sample Preservation	11
	C. Field Analyses	11
	D. Flow Measurement	12
	E. Time of Travel	12
	F. Sediment Oxygen Demand	13
IV.	Laboratory Procedures	14
	A. Chlorophyll *a*	14
	B. Nitrogen Series	14
	C. Phenol	15
	D. Cyanide	15
	E. Metals	15
	F. Sediments	15
	G. DO/BOD	17
	H. Long Term BOD	19

Table of Contents (con't)

		Page
V.	Results	22
	A. Stream Survey	22
	B. Effluent Survey	31
	C. Long Term BOD Experiment	37
	D. Diurnal Study	82
	E. Flow Measurement	85
	F. Time of Travel	87
	G. Benthic Characterization	89
VI.	Conclusions	92
VII.	Appendices	94

Tables

		Page
II-1	Stream Stations	4
II-2	Zinc Sampling Stations	5
II-3	Effluent Sampling Stations	6
II-4	Diurnal Stations	8
V-A-1	Field Data From Stream Samples	22
V-A-2	Nutrient and BOD Data From Stream Samples	25
V-A-3	Chlorophyll a Data From Stream Samples	27
V-A-4	Phenol Data From Stream Samples	28
V-A-5	Cyanide Data for Stream Samples	29
V-A-6	Zinc Data for Stream Samples	30
V-B-1	Effluent Grab Sample Data	31
V-B-2	Effluent Composite Sample Data	33
V-B-3	Phenol Data for Effluent Samples	35
V-B-4	Cyanide Data for Effluent Samples	36
V-C-1	Long Term BOD Data for Unaltered River Samples	37
V-C-2	Long Term BOD Data for Seeded Effluent Samples	48
V-C-3	Long Term BOD Data for Seeded and Diluted Effluent Samples	54
V-C-4	Thomas Graphical Determination of BOD Constants for Unaltered River Samples	55
V-C-5	Thomas Graphical Determination of BOD Constants for Seeded Effluent Samples	70
V-C-6	Thomas Graphical Determination of BOD Constants for Seeded and Diluted Effluent Samples	75

Tables (con't)

		Page
V-C-7	Compilation of CBOD River Sample Kinetics	79
V-C-8	Compilation of NOD River Sample Kinetics	80
V-C-9	Compilation of CBOD and NOD Kinetics for Effluent Samples	81
V-D-1	Diurnal Data	82
V-E-1	Major Discharge Flows	85
V-E-2	Stream Flows	86
V-F-1	Time of Travel 1977	87
V-F-2	Time of Travel 1976	88
V-G	Benthic Characterization	91

Figures

		Page
V-G-1	Sediment Oxygen Demand	90
C-1	Benthic Respirometer	99
C-2	Typical Graph and Worksheet from Respirometer	100

I. Purpose and Scope

During the week of October 3, 1977, the Annapolis Field Office and the Pennsylvania Department of Environmental Resources Reading jointly conducted a one week intensive survey on the lower reach of the Lehigh River between Palmerton and the mouth. The study was designed to define low-flow water quality, hydrologic and benthic characteristics necessary for calibration and verification of a mathematical model being developed by the EPA Region III Water Planning Branch. The water quality characterization included analysis of stream and major discharge samples for dissolved oxygen (DO), biochemical oxygen demand (BOD), nitrogen series and other indicators of water quality conditions; a 24 consecutive hour sampling program to define diurnal fluctuations in DO; and a long term laboratory experiment designed to differentiate between carbonaceous and nitrogenous components of the long term BOD. The hydrological aspects of the study included stream gaging; flow measurement at major discharges; and a dye study to determine travel times in various segments of the river. In situ sediment oxygen demand (SOD) measurements and analysis of sediment samples for nutrients and selected metals were included in the benthic characterization program.

The study was planned for what was expected to be a low stream flow period so that water quality responses to pollutant loadings could be evaluated under the most severe conditions. The optimal flow condition for the study would have been about 600 CFS in the Lehigh River. Unfortunately,

the study period was preceded by heavy rainfall which increased flows to over 2000 CFS. The U.S. Army Corps of Engineers participated in the study effort by restricting releases from the upstream reservoirs on the Lehigh. Through the release restrictions, the Corps was able to decrease the river flow to about 1500 CFS by the end of the study period. The study was initiated despite the high flows in hopes that the release restrictions could drop the flow below 1000 CFS and because a good steady-state low flow, moderate temperature condition would not occur for another year.

The U.S. Geological Survey also cooperated in the study by measuring cross-sectional areas and flows at selected places in the river. The results of their program are reported separately.

II. Study Description

The Annapolis Field Office and the Pennsylvania DER shared in both the field and laboratory segments of the survey. AFO field teams conducted stream sampling from Allentown to Easton, effluent sampling at Bethlehem Steel, time of travel, and benthic characterizations. Pennsylvania DER field personnel were responsible for effluent sampling at Allentown and Bethlehem sewage treatment plants and the New Jersey Zinc Friedensville Mine, stream sampling above Allentown, and stream flow measurement. Teams from both DER and AFO participated in the diurnal study. The cyanide analyses were performed by the DER laboratory in Harrisburg and all of the the other laboratory analyses were done at AFO.

A. Stream Sampling

On each of three consecutive days (10/4, 10/5, 10/6) stream samples were collected at the stations shown in Table II-1. For the stations on the Lehigh River, spatial composite samples (see III-A for explanation) were collected and for tributary stations mid-channel grab samples were collected. DO, pH and temperature were measured in the field and all samples were anlayzed for BOD_5, TKN, NH_3, NO_2, NO_3, NBOD (nitrogenous BOD) and CBOD (carbonaceous BOD). One sample from each station was analyzed for zinc, cyanide, phenol and chlorophyll a sometime during the study. (Analyses for these parameters were staggered to avoid overloading the AFO laboratory.)

At the suggestion of Pennsylvania DER, two sets of grab samples were taken between Palmerton and Allentown for zinc analysis. This was done to monitor the effect of the discharges from New Jersey Zinc's Palmerton plant. Table II-2 lists the locations for the zinc monitoring stations.

B. Effluent Sampling

Starting on Monday October 3, 1977, three consecutive 24-hour composite samples were taken at each of the discharge points listed in Table II-3. All of the composite samples were analyzed for pH, BOD_5, TKN, NH_3, NO_2, NBOD and CBOD except those from New Jersey Zinc which were only analyzed for zinc. Grab samples were collected once each day at each station for pH, temperature and DO. With the exception of New Jersey Zinc, all of the effluent samples collected during the first compositing period were analyzed for cyanide and phenol.

C. Long Term BOD Experiment

A laboratory experiment was conducted to measure the carbonaceous

Table II-1
Stream Stations

Station No.	Lehigh River Mile	Tributary River Mile	Station Description
A			Lehigh at Catasaqua Bridge
B			Aquashicola Creek at Bridge near Lehigh River Junction
C			Lehigh at Route 895 Bridge
D			Lehigh at Route 946 Bridge/Slatington-Walnutport
L-1	17.3		Lehigh at Hamilton Street Bridge
L-3	14.1		Lehigh at Mile 14.1
L-4	11.8		Lehigh at New Street Bridge
L-5	11.0		Lehigh at Minsi Trail Bridge
L-9	9.6		Lehigh at Freemansburg Bridge
L-10	7.9		Lehigh at Steel City
L-11	6.2		Lehigh at West End Bethlehem Boat Clu
L-12	4.9		Lehigh at West End Island Park
L-13	3.3		Lehigh upstream of Glendon Dam
L-14	2.3		Lehigh at 25th Street Bridge
L-15	1.5		Lehigh at 25th Street Bridge
L-16	0.3		Lehigh at 3rd Street Bridge
S-6		S1.43	Saucon Creek at Five Lane Bridge
S-7		S0.5	Saucon Creek above Bethlehem City STP Outfall
S-8	9.8	S0.1	Saucon Creek at Mouth
T-1	16.8		Little Lehigh at Mouth
T-2	11-8		Monocacy Creek at Mouth
T-6		S0.55	Laubach Creek at Mouth

Table II-2
Zinc Sampling Stations Palmerton to Allentown

Station	Location
A	Lehigh at Catasaqua Bridge
B	Aquashicola Creek at Bridge Near Lehigh River Junction
C	Lehigh at Route 895 Bridge
D	Lehigh at Route 946 Bridge/Slatington-Walnut port

Table II-3
Effluent Sampling Stations

Source	Outfall No.	Station No.	Lehigh River Mile	Tributary River Mile
Allentown STP	001	AL001	16.85	
Bethlehem STP	001	BE001	9.82	S0.25*
Bethlehem Steel	005	BS005	11.6	
Bethlehem Steel	006	BS006	11.44	
Bethlehem Steel	007	BS007	11.37	
Bethlehem Steel	008	BS008	11.28	
Bethlehem Steel	010	BS010	10.75	
Bethlehem Steel	012	BS012	10.61	
Bethlehem Steel	014	BS014	10.36	
Bethelhem Steel	015	BS015		S1.225
Bethlehem Steel	031	BS031		S0.25

* Flow is split between outfalls going to Saucon Creek and the Lehigh River.

and nitrogenous components of long term (30 day) BOD. While no standard exists for measuring these parameters, a number of techniques have been employed successfully. AFO used two of these techniques during this study. The first technique was the more rigorous of the two and required periodic measurement of DO and nitrogen fractions over the duration of the experiment. Total oxygen demand was measured using the change in DO while the nitrogenous component was derived using the changes in the states of nitrogen. The second technique involves the use of a nitrification inhibitor and the measurement of total and carbonaceous oxygen demands exerted over a 30 day period. Detailed descriptions of both techniques are included in Section IV.

D. Diurnal Study

Begining at 8:00 a.m. on October 5, 1977, a 24-hour survey was conducted to measure the diurnal DO fluctuations at the stations listed in Table II-4. Five (5) sets of samples were collected at each station during the study. Spatial composite samples were made for chlorophyll a analysis and the component samples were analyzed individually for DO, temperature and pH.

E. Flow Measurement

Stream flow measurements, with one exception, are from USGS gaging stations located on the Lehigh River and its tributaries. The exception, Saucon Creek, was manually gaged using a velocity meter and the appropriate geometric data. Stream flow measurements were made on October 4 and October 6.

Table II-4
Diurnal Stations

Station No.	Location
L-1	Hamilton Street Bridge
L-4	New Street Bridge
L-9	Freemansburg Bridge
L-11	West End Bethlehem Boat Club
L-14	25th Street Bridge Easton
L-16	3rd Street Bridge Easton

Flows at the two sewage plants are continuously monitored and were available from the flow totalizers. The New Jersey Zinc flow is an estimate. Bethlehem Steel flows were measured by the company during the week of the survey as a requirement under their NPDES discharge permit.

F. Time of Travel

Travel times and average stream velocities were measured for an 11 mile reach of the Lehigh River using a fluorometric dye tracing technique. Rhodamine B dye was released into the river at mile point 17.3 and the time of passage past 3 downstream points (river miles 12.55, 9.4, 6.0) was measured.

G. Benthic Characterization

The sediment oxygen demand (SOD) was measured using an in situ respirometer at Station L-13 (see Table II-1). It had been planned to measure SOD at Station L-16 also but due to the physical limitations of the respirometer system it was not feasible. A bottom grab sample was taken at Station L-16 and analyzed for TKN, TP, TOC, zinc, chromium, cadmium, copper, lead and iron.

III. Field Procedures

A. Sample Collection

1. Stream Samples were all surface grab samples taken in clean plastic buckets. At main river stations, separate samples were taken at each of the three quarter points across the stream. (These samples are

designated as right, center and left quarter points looking upstream.) Temperature, DO and pH were measured for each of the quarter point samples and composite samples for laboratory analysis were made using equal portions from each of the quarter point samples. For the tributary stations only one surface grab sample was collected at the point most representative of the total stream flow. Temperature, DO and pH were measured for the sample and a portion was preserved for laboratory analysis.

2. Effluent Samples were either grab samples or 24 hour time proportioned composite samples taken as close as possible to the point of discharge to the receiving stream. Grab samples, one each day at each station, were taken in plastic buckets for temperature and DO analysis. Temperature was measured in the bucket and samples for DO analysis were poured into standard 300 ml DO bottles through a funnel to avoid excessive aeration. Composite samples were collected using ISCO (both models 1392 and 1580) automatic samplers. Composite sample aliquots were collected at half hour intervals at all stations except New Jersey Zinc which was sampled at 20 minute intervals. Sample temperatures were maintained at about 6^{o}C using ice in the samplers .

3. Sediment Samples were grab samples collected using a model 426/SM Mud Snapper made by GM Manufacturing and Instrument Corporation. After collection, the samples were stored unpreserved in plastic cups.

4. Containers. Samples for nutrient/BOD analyses were stored unpreserved in new gallon plastic cubitainers. Phenol samples were stored

in acid washed glass containers. Zinc and chlorophyll a samples were each stored in separate new quart cubitainers. Cyanide samples were stored in clean glass bottles.

B. Sample Preservation

All samples except those for dissolved oxygen analysis were kept at $4^{o}C$ until they were analyzed.

1. Phenol samples were preserved by adjusting the sample pH to less than 4 with phosphoric acid and adding copper sulfate.

2. Cyanide samples were preserved by adjusting the sample pH to more than 12 with sodium hydroxide.

3. Zinc samples were preserved by adjusting the sample pH to less than 2 with nitric acid.

4. Dissolved Oxygen (DO) samples were preserved with 2 ml manganous sulfate solution, 2 ml potassium hydroxide-potassium iodide solution and 2 ml of concentrated sulfuric acid. The samples were stored in the dark until the analyses were performed.

C. Field Analyses

1. Temperature was measured using a YSI dissolved oxygen meter for samples on which DO analysis was done in the field. Other temperature measurements were made with a calibrated thermometer.

2. Dissolved Oxygen (mg/l DO) in the stream samples was determined with a YSI DO Probe #5739 and YSI Meter Model 57. The meters and probes were air calibrated and measurements were made while manually stirring.

Ref: EPA Methods for Chemical Analysis of Water and Wastes, 1974, p. 56.

3. pH was measured using Leeds and Northrop Model 7417 pH meters with Ingold number 2761 7-02 pH electrodes. Meters were calibrated using buffer solutions with pH 4, 7 and 10. Measurements were recorded after the meter reached equilibrium in the sample.

D. Flow Measurement

1. Stream Flows were read from USGS gage stations with the exception of Saucon Creek which was manually gaged using a cup type velocity meter.

2. Waste Discharge Flows for the Allentown and Bethlehem sewage treatment plants were read from the totalizers on the continuous recording flow meters at the plants. Flows from Bethlehem Steel were measured by the company as required by their NPDES discharge permit. The company did only one measurement at each outfall and the methods of measurement included use of V-notch weirs and lithium dilution techniques. Flows for New Jersey Zinc are company estimates.

E. Time of Travel

Travel time in the river was measured using a fluorometric dye technique. One quart of Rhodamine B dye was released into the river at

the Hamilton Street Bridge, Allentown (river mile 17.3) at 3:00 a.m. on October 5, 1977. The time of passage for the dye mass was subsequently measured at three downstream points. The dye cloud was tracked using a continuous flow through fluorometer system consisting of a submersible pump, a Turner Model 111 Fluorometer with a flow through door and Corning orange (3-66) and blue (4-97) filter, and a Rustrak strip chart recorder. The submersible pump was placed in the river and sample was continuously pumped through the fluorometer flow-through door. The recorder provided a continuous graph of dye concentration in the river and the elapsed time between stations was taken when the maximum dye concentration (peak) was recorded. Average velocity for each reach of stream was calculated using the distance between two stations and elapsed time for the dye peak to travel between the two stations.

F. Sediment Oxygen Demand

Sediment oxygen demand (SOD) was measured at Station L-13 using a benthic respirometer. (See Appendix C for explanation and description of respirometer.) The respirometer was lowered from a boat into soft sediment where it could make a watertight seal. The DO of the water trapped beneath the respirometer was measured initially and the changing DO level was monitored over an 80 minute period. A DO bottle filled with bottom water was attached to the respirometer and the initial and final DO was measured to isolate the demand exerted by the water.

IV. Laboratory Procedures

A. Chlorophyll a (ug/l chl. a): The photosynthetic pigment, chlorophyll was retained on a membrane filter and extracted into acetone with grinding. The extracted solution was measured spectrophotometrically.

Ref: Strickland, J.D.H., and Parsons, T.R., "A Manual of Sea Water Analysis", Bulletin 125, Fisheries Research Board of Canada, Ottowa, 1960, p.185.

B. Nitrogen Series

1. Total Kjeldahl Nitrogen (mg/l TKN-N): The water samples were automatically digested and analyzed by a Technicon Continuous Digestor and Auto Analyzer for ammonia and organic nitrogen. The method of analysis was the colorimetric phenolate method.

Ref: EPA Methods for Chemical Analysis of Waters and Wastes, 1974, p. 182[1].

2. Ammonia (mg/l NH_3-N): was analyzed by a Technicon Auto Analyzer employing the colorimetric phenolate method.

Ref: EPA Methods for Chemical Analysis of Water and Wastes, 1974, p. 168.

3. Organic Nitrogen (mg/l ORG-N): was determined by difference, (TKN-N) - (NH_3-N) .

4. Nitrate plus Nitrite (mg/l NO_2 - N + NO_3 - N): was analyzed with a Technicon Auto Analyzer. This procedure utilized the cadmium reduction of nitrate to nitrite and subsequent diazotization with the optical density measured at 540 nm.

Ref: EPA Methods for Chemical Analysis of Water and Wastes, 1974, p. 207.

5. Nitrite (mg/l NO_2-N): was determined as for NO_2 + NO_3 with a Technicon Auto Analyzer but the cadmium reduction step was by-passed.

Ref: EPA Methods for Chemical Analysis of Water and Wastes, 1974, p. 215.

6. Nitrate (mg/l NO_3-N):was determined by difference, (NO_2-N + NO_3-N) - (NO_2-N)

C. Phenol (mg/l Phenol): was determined colorimetrically via the 4-amino-anti-pyrine method. The samples were distilled to remove potential interferences.

Ref: EPA Methods for Chemical Analysis of Water and Wastes, 1974, p. 241.

D. Cyanide (mg/l CN): was measured using a Technicon Auto Analyzer colorimetric procedure with UV light and pyridine-barbituric acid as the color reference.

Ref: Technicon Automated UV Digestion Method

E. Metals (mg/l Total): Total Zn; Mn; Fe; Pb; Cd; Cu; and Cr were quantitatively determined by atomic absorption spectrophotometry using a Varian AA-6 A.A. Spectrophotometer. Water samples were treated with nitric acid and refluxed on a hot plate until digestion was complete.

Ref: EPA Method for Chemical Analysis of Water and Wastes, 1974, p. 78.

F. Sediments

1. Total Residue (% Dry Weight): The % dry weight was determined by placing ≈ 5 ml of sample in a crucible which had been previously heated for 24 hours at 103 - 105 ^{0}C for 24 hours and cooled in a dessicator before weighing. The "wet" weight was then determined and the sample plus crucible returned to the 103 - 105 ^{0}C oven for 24 hours. The final "dry" weight of the sample after drying is then determined and the % dry weight calculated.

2. Total Organic Carbon (% Dry Weight - TOC): Predried samples (at 35^{0}C for 24 hours) were analyzed by the Oceanography International Total Carbon System. The sample, potassium persulfate and phosphoric acid were sealed in glass ampules and autoclaved at 230^{0}C for four hours. Organic materials contained in the sediment samples were converted to carbon dioxide

by this wet chemical oxidation step.

Ref: EPA Methods for Chemical Analysis of Water and Wastes, 1974, p. 236.
Instruction and Procedure Manual for Oceanography International

3. Total Kjeldahl Nitrogen (% Dry Weight - TKN-N): The procedure for sediment samples was the same as that employed for water samples but digestion of 0.05 gms of sediment (wet weight) was carried out using potassium sulfate and sulfuric acid. The mixture was refluxed over a flame until the organic nitrogen was converted to ammonium. The answer was corrected to % dry weight using the dry weight determination described previously.

Ref: EPA Methods for Chemical Analysis of Water and Wastes, 1974, p. 182.

4. Total Phosphorus (% dry weight - TPO_4): Total Phosphorus in sediment samples was determined by manually digesting (in an autoclave for 30 minutes at 15 psi) the sample with ammonium persulfate and sulfuric acid to convert the various forms of phosphorus to orthophosphate. The orthophosphate was measured on a Technicon Auto Analyzer. In this colorimetric method ammonium molybdate reacts with the orthophosphate in the acid medium to form a heteropoly acid, molybdophosphoric acid. This acid is reduced by ascorbic acid to form the intensely colored complex, molybdenum blue. The amount of color produced is directly proportional to the amount of phosphorus present.

Ref: EPA Methods of Chemical Analysis of Water and Wastes, 1974, p. 256.

5. Metals (mg/kg dry weight): Sediments were anlayzed for Cr; Cd; Cu; Pb; Fe; and Zn via atomic absorption spectrometry using a Varian AA-6 Spectrophotometer. The sample preparation and digestion were as follows:

1. Sample dried at 35°C (minimum of 24 hours).

2. Removed from incubator/oven and ground to "natural" particle size (large rocks, shell, leaves, etc. removed).

3. Sample dried additional 24 hours.

4. Sample weighed; 3-5 grams for silts and clays, 15 grams for sands (i.e., ocean sediments).

5. Transfer to glass-stoppered Erlenmeyer.

6. Add equal volumes deionized-distilled water and concentrated HNO_3 ($\sim$ 20 - 25 ea. = 8N).

7. Heat in shaking water bath at 58°C for 4-6 hours.

8. Filter with .45 micron membrane filter, dilute to 100 ml.

9. Sample is now ready for analysis.

G. DO/BOD

1. Dissolved Oxygen (mg/l D.O.): in the effluent samples was determined by the azide modification of the basic Winkler Method, with the titration done potentiometrically with a Fisher Automatic Titralyzer. Ref: EPA Methods for Chemical Analysis of Water and Wastes, 1974, p. 51.

2. Biochemical Oxygen Demand (mg/l BOD_5) : The samples were incubated at 20°C for five days in the dark. The reduction in dissolved oxygen (as measured by YSI #5750 BOD probe) concentration during the incubation period yielded a measure of the biochemical oxygen demand.

River water samples were analyzed for BOD unaltered, incorporating indigenous biota and nutrients.

The following Bethlehem Steel samples were altered by the addition of 1 ml of stale settled sewage (seed) per 300 ml of sample: outfall 005; 006; 007; 008; 010; and 012. The seed was obtained from the Maryland Department of Natural Resources.

The addition of seed was to assure the presence of an adequate bacterial population. This alteration necessitated that a blank (distilled water plus 1 ml of "seed") be carried through this experiment to compensate for potential BOD contamination.

The following STP and industrial effluent samples were altered by the addition of "seed" (1ml/bottle) and by dilution with APHA dilution water: Allentown STP; Bethlehem Steel outfall 015 and 031; and Bethlehem City Municipal STP. Allentown STP samples were found to have significant residual chlorine content and $\simeq$ 1.0 mg/l of sodium sulfite solution (0.025N Na_2SO_3) was added to eliminate this potential interference. These alterations necessitated that a blank (300 ml APHA dilution water plus 1 ml of "seed") be carried through this experiment to compensate for potential BOD contamination. A dilution factor is also included in these calculations.

Ref.: EPA Methods for Chemical Analyses of Water and Wastes, 1974, p. 11.

H. Long Term BOD

A set of laboratory experiments was conducted to characterize long term oxygen demand and to differentiate between the nitrogenous and carbonaceous components of long term BOD. The long term oxygen demand was estimated by extending the standard BOD test incubation period from 5 days to 30 days. The nitrogenous component of total BOD was estimated by measuring the changes in the states of nitrogen during the course of the BOD incubation and also independently by a method of differences in which a nitrification inhibitor was used.

For determination of the BOD_{30}, samples were set up as described previously with the exception that 6 replicate sample bottles were used as part of the nitrification experiment. The dissolved oxygen was measured for each sample after 0; 6; 12; 20; and either 29 or 31 days of incubation to determine the long term BOD.

One of the six replicates mentioned in the previous paragraph was sacrificed after 0; 6; 12; and either 29 or 31 days of incubation to measure Total Kjeldhal Nitrogen (TKN); ammonia (NH_3); nitrite (NO_2); and nitrate (NO_3). The changes in concentration in the states of nitrogen were used to calculate the nitrogenous oxygen demand by the equation:

$$NOD\ (mg/l) = 3.43\ (\Delta NO_2\text{-}N + \Delta NO_3\text{-}N) + 1.14\ (\Delta NO_3\text{-}N)$$

where Δ = final concentration - initial concentration.

An inhibitor 2-chloro-6(trichloromethyl) pyridine (TCMP) was also employed as part of the long term study. Two bottles of the six replicates were spiked with TCMP and the dissolved oxygen measured. The

inhibitor was added to stop nitrification while allowing all other heterotrophic respiration to proceed. The inhibited bottles expressed only carbonaceous demand whereas the uninhibited bottles expressed the total BOD demand (NOD + CBOD). By difference the nitrogenous oxygen demand was calculated.

The first-order deoxygenation constants $k_{10}(day^{-1})$ of the NOD[4] and CBOD as measured by the inhibitor were determined by a graphical method. This method relies upon the observation that the relation $(1-10^{-kt})$ of the classical BOD equation $y = L_o (1-10^{-kt})$ is very similar to the expression $2.3\ k_{10}t\ [1+(2.3/6)k_{10}t]^{-3}$, where k_{10} is the deoxygenation constant (day^{-1}) and L_o is the initial remaining oxygen demand at time $t = 0$.

Together the two equations reduce to:
$y = L_o\ 2.3\ kt\ [1+(2.3/6)kt]^{-3}$ or $(t/y)^{1/3} = (1/2.3\ L_o k) + (2.3k)^{2/3}t/(6L_o)^{1/3}$, such that a plot of $(t/y)^{1/3}$ vs t yields a linear relation with slope $m = (2.3k)^{2/3}/(6L_o)^{1/3}$ and intercept $b = 1/(2.3k\ L_o)^{1/3}$. The BOD k_{10} and L_o values can therefore be determined as follows: $k = 2.61\ m/b$ and $L_o = 1/(2.3\ b^3 k)$. The correlation coefficient for this linear approximation was taken as an indication of the "goodness-of-fit" to the first order kinetics.

Limitations of Long Term Laboratory BOD Experiments

1. It should be emphasized that this was not a standard method and that the data reflects not only the imprecision of the analytical methods (Appendix B) for determining the states of nitrogen but also the variability associated with biological processes. The interpretation of the results should include a consideration of this variability.

2. Nitrification is an extremely fragile biological process and is affected greatly by environmental conditions. The problems with using laboratory experiments to study field conditions (in situ) are therefore potentially significant.

3. Nitrification is a surface phenomenon with much of nitrification in clear shallow rivers occuring on the surfaces of mud (aerobic), plants, slime, etc.[2] Laboratory experiments involving the incubations of clear-shallow stream samples may not reflect the extent of in situ nitrification. The Lehigh River remained quite turbid during this study and significant nitrification activity was expected in the water column.

TABLE V - A-1

LEHIGH RIVER STUDY

FIELD DATA FROM STREAM SAMPLES

Station	Date	Time	Location	pH (SU)	Temp. (°C)	D.O (PPM)
L- 1	10/4	1650	Right	----	14.5	10.8
			Center	----	-----	10.8
			Left	----	-----	10.8
			Avg.	----	14.5	10.8
L- 3	10/4	1730	Left	----	15.0	9.6
L- 4	10/4	1604	Right	----	14.5	10.8
			Center	----	-----	10.8
			Left	----	-----	10.5
			Avg.	----	14.5	10.7
L- 5	10/4	1517	Right	7.2	15.0	10.2
			Center	7.1	15.0	9.2
			Left	7.25	15.0	10.2
			Avg.	7.18	15.0	9.9
L- 9	10/4	1308	Right	7.2	13.0	11.2
			Center	7.25	14.0	10.9
			Left	7.4	14.5	10.7
			Avg.	7.28	13.8	10.9
L-10	10/4	1030	Right	----	13.5	9.5
			Center	----	13.5	9.6
			Left	----	13.5	9.6
			Avg.	----	13.5	9.53
L-11	10/4	1115	Right	----	13.8	9.15
			Center	----	13.8	9.25
			Left	----	14.0	9.0
			Avg.	----	13.86	9.13
L-12	10/4	1140	Right	----	14.0	9.2
			Center	----	14.0	9.15
			Left	----	13.9	9.05
			Avg.	----	13.9	9.13
L-13	10/4	1200	Right	----	14.0	8.75
			Center	----	14.0	8.75
			Left	----	14.0	8.9
			Avg.	----	14.0	8.78
L-14	10/4	1030	Right	6.9	14.0	9.6
			Center	6.9	14.0	9.4
			Left	6.9	14.0	9.7
			Avg.	6.9	14.0	9.53
L-15	10/4	1047	Right	6.75	14.3	9.6
L-16	10/4		Right	6.7	14.0	9.6
			Center	7.2	14.0	9.6
			Left	7.2	14.0	9.6
			Avg.	7.0	14.0	9.6
S- 6	10/4	1430	Surf.	7.9	15.0	---
S- 7	10/4	1340	Surf.	7.9	15.0	9.8
S- 8	10/4	1330	Surf.	7.2	15.5	9.4
T- 1	10/4	1750	Surf.	----	14.5	10.0
T- 2	10/4	1545	Surf.	7.8	14.0	11.8

TABLE V - A-1 (CONTINUED)

LEHIGH RIVER STUDY

FIELD DATA FROM STREAM SAMPLES

Station	Date	Time	Location	pH (SU)	Temp. (°C)	D.O. (ppm)	Chlorophyll a (ppb)
L-1	10/5	1700	Right	7.3	14.0	----	----
			Center	---	14.0	----	----
			Left	---	14.0	----	----
			Avg./Comp.	7.3	14.0	----	3.0
L-3	10/5	1510	Surf.	6.0	15.0	9.5	1.5
L-4	10/5	1600	Right	7.3	14	----	----
			Center	---	14	----	----
			Left	---	14	----	----
			Avg./Comp.	7.3	14	----	3.0
L-5	10/5	1500	Right	7.4	15	10.0	----
			Center	---	15	10.0	----
			Left	---	15	10.0	----
			Avg./Comp.	---	15	10.0	4.5
L-9	10/5	1425	Right	---	16.0	9.6	----
			Center	---	16.0	10.2	----
			Left	---	16.0	9.9	----
			Avg./Comp.	---	16.0	9.9	3.0
L-10	10/5	1115	Right	6.0	15.0	9.4	----
			Center	6.0	14.0	9.4	----
			Left	6.0	14.0	10.0	----
			Avg./Comp.	6.0	14.5	9.6	3.0
L-11	10/5	1048	Right	6.0	14.0	9.4	----
			Center	6.0	14.0	9.7	----
			Left	6.0	14.0	9.3	----
			Avg./Comp.	6.0	14.0	9.36	3.0
L-12	10/5	1029	Right	6.0	14.0	----	----
			Center	6.0	14.0	----	----
			Left	6.0	14.0	----	----
			Avg./Comp.	6.0	14.0	----	10.5
L-13	10/5	1000	Right	6.0	14.0	8.4	----
			Center	6.0	14.0	8.0	----
			Left	6.0	14.5	9.6	----
			Avg./Comp.	6.0	14.16	8.66	7.5
L-14	10/5	1215	Right	---	16.0	9.4	----
			Center	6.0	16.0	9.8	----
			Left	---	15.0	9.9	----
			Avg./Comp.	6.0	15.7	9.7	6.0
L-15	10/5	1230	Surf.	6.0	16.0	9.4	4.5
L-16	10/5	1255	Right	6.0	15.5	9.2	----
			Center	6.0	15.5	9.8	----
			Left	6.0	15.0	9.4	----
			Avg./Comp.	6.0	15.3	9.5	3.0
S-6	10/5	1050	Surf.	8.1	13	---	0
S-7	10/5	1200	Surf.	8.0	15	---	3.0
S-8	10/5	1205	Surf.	7.6	16.5	---	0
T-1	10/5	1540	Surf.	6.0	15.5	10.0	4.5
T-2	10/5	1535	Surf.	8.0	----	---	1.5
T-6	10/5	1145	Surf.	7.8	17	8.73	---

TABLE V - A-1 (CONTINUED)

LEHIGH RIVER STUDY

FIELD DATA FROM STREAM SAMPLES

Station	Date	Time	Location	pH (SU)	Temp. (°C)	D.O. (ppm)
L-1	10/6	1005	Right	7.0	12.0	10.8
			Center	---	12.2	10.7
			Left	---	12.2	10.7
			Avg.	---	12.1	10.7
L-3	10/6	1140	Surf.	7.1	12.8	9.15
L-4	10/6	1230	Right	7.1	12.8	10.48
			Center	---	12.8	10.35
			Left	---	12.8	9.7
			Avg.	7.1	12.8	10.14
L-5	10/6	1315	Right	7.3	14.5	9.85
			Center	---	13.7	10.2
			Left	---	13.8	9.9
			Avg.	7.3	14.0	10.0
L-9	10/6	0945	Right	6.7	13.5	10.0
			Center	6.6	14.0	10.2
			Left	6.4	14.5	9.6
			Avg.	6.56	14.3	9.93
L-10	10/6	1240	Right	6.5	14.5	9.6
			Center	7.0	14.5	9.2
			Left	6.5	14.5	9.0
			Avg.	6.66	14.5	9.26
L-11	10/6	1300	Right	6.3	14.5	10.0
			Center	6.7	14.5	9.1
			Left	6.9	14.5	9.1
			Avg.	6.66	14.5	9.4
L-12	10/6	1315	Right	6.6	15.0	8.4
			Center	6.8	15.0	8.6
			Left	6.9	15.0	8.4
			Avg.	6.76	15.0	8.46
L-13	10/6	1340	Right	6.5	16.0	8.4
			Center	6.8	15.0	8.3
			Left	6.9	16.0	8.4
			Avg.	6.73	15.6	8.38
L-14	10/6	1140	Right	6.8	14.0	9.6
			Center	6.8	14.0	9.6
			Left	6.5	14.0	9.4
			Avg.	6.7	14.0	9.53
L-15	10/6	1020	Surf.	6.2	14.0	9.8
L-16	10/6	1050	Right	6.7	14.0	9.8
			Center	6.5	14.0	9.6
			Left	6.4	14.0	10.4
			Avg.	6.53	14.0	9.93
S-6	10/6	0950	Surf.	7.7	13.0	----
S-7	10/6	1345	Surf.	7.6	15	----
S-8	10/6	1325	Surf.	7.6	---	----
T-1	10/6	1040	Surf.	7.5	12.5	9.4
T-2	10/6	1210	Surf.	7.8	12.0	10.3
T-6	10/6	1335	Surf.	7.4	15.8	8.58

TABLE V A-2
CONTINUED
LEHIGH RIVER STUDY

NUTRIENT AND BOD DATA FOR STREAM SAMPLES

Station	Date	Time	TKN-N (ppm)	NH_3-N (ppm)	N-org (ppm)	$(NO_2 + NO_3)$-N (ppm)	NO_2-N (ppm)	NO_3-N (ppm)	BOD_6 (ppm)	$BOD_{29(31}$ (ppm)	Chlorophyll a (ppb)
S-7	10/5	1200	12.900	12.9	0	1.54	.160	1.380	6.3	37.7	----
S-8	10/5	1205	17.263	14.4	2.863	1.34	.157	1.183	9.8	43.4	----
L-1	10/6	1005	.295	N/D	.295	1.26	N/D	1.26	1.0	2.4	----
L-3	10/6	1140	1.181	.520	.661	L/A	.049	----	3.2	7.7	----
L-4	10/6	1230	.738	.251	.487	1.62	N/D	1.62	2.0	4.6	----
L-5	10/6	1315	.664	.237	.427	1.68	N/D	1.68	1.9	4.8	----
L-9	10/6	0945	1.461	1.05	.411	1.76	.043	1.717	3.9	L/A	----
L-10	10/6	1240	1.491	1.09	.401	L/A	.056	----	3.7	9.4	----
L-11	10/6	1300	1.491	1.03	.461	1.84	.058	1.782	3.2	9.6	----
L-12	10/6	1315	1.446	.963	.483	1.90	.058	1.842	3.8	9.2	----
L-13	10/6	1340	1.506	.984	.522	1.89	.058	1.832	3.4	8.3	----
L-14	10/6	1140	1.535	1.03	.505	1.91	.065	1.845	3.6	9.7	----
L-15	10/6	1020	1.535	.917	.618	1.94	.065	1.875	4.8	9.4	----
L-16	10/6	1050	1.491	.957	.534	1.94	.061	1.879	2.9	8.2	----
T-1	10/6	1040	.752	N/D	.752	L/A	N/D	L/A	5.4	10.2	----
T-2	10/6	1210	.546	N/D	.546	L/A	N/D	L/A	4.8	8.1	----
T-6	10/6	1335	L/A	6.49	---	4.67	.397	4.28	11.7	27.6	----
S-6	10/6	0950	.517	N/D	.517	1.32	N/D	1.32	2.3	4.0	----
S-7	10/6	1345	14.760	11.3	3.460	1.76	.188	1.572	11.3	38.7	----
S-8	10/6	1325	14.170	14.0	.170	1.43	.149	1.281	9.2	41.0	----

* N/D - not detectable
** L/A - laboratory accident

TABLE V A-2

LEHIGH RIVER STUDY

NUTRIENT AND BOD DATA FOR STREAM SAMPLES

Station	Date	Time	TKN-N (ppm)	NH_3-N (ppm)	N-org (ppm)	$(NO_2 + NO_3)$-N (ppm)	NO_2-N (ppm)	NO_3-N (ppm)	BOD_6 (ppm)	$BOD_{29/31}$ (ppm)	Chlorophyll a (ppb)
L-1	10/4	1650	.676	.096	.580	1.16	N/D*	1.16	3.6	7.8	----
L-3	10/4	1730	1.460	.771	.689	2.11	.059	2.056	4.1	11.2	----
L-4	10/4	1604	1.203	.204	.999	1.50	N/D	1.50	1.8	4.7	----
L-5	10/4	1517	.707	.249	.458	1.62	N/D	1.62	3.1	6.5	----
L-9	10/4	1308	1.338	.815	.523	1.51	N/D	1.51	3.3	8.0	----
L-10	10/4	1030	1.284	.796	.488	1.47	N/D	1.47	2.8	7.4	----
L-11	10/4	1115	1.230	.700	.530	1.57	N/D	1.57	2.7	6.7	----
L-12	10/4	1140	1.149	.678	.471	1.58	.041	1.539	1.4	6.3	----
L-13	10/4	1200	1.487	.804	.683	1.52	.041	1.479	1.6	7.3	----
L-14	10/4	1030	1.149	.808	.341	1.71	.052	1.658	1.9	7.4	----
L-15	10/4	1047	1.446	.707	.442	1.59	.054	1.536	1.9	6.5	----
L-16	10/4	1102	.811	.799	.017	1.58	.056	1.524	2.5	7.9	----
T-1	10/4	1750	1.378	N/D	1.378	3.16	N/D	3.16	2.5	5.8	----
T-2	10/4	1545	.284	N/D	.284	3.80	N/D	3.80	1.2	2.6	----
S-6	10/4	1430	.419	.075	.344	1.38	N/D	1.38	1.9	3.6	----
S-7	10/4	1340	17.028	14.3	2.728	1.47	.110	1.360	8.0	41.8	----
S-8	10/4	1330	17.296	13.4	3.896	1.61	.178	1.432	11.1	42.7	----
L-1	10/5	1700	.407	.050	.357	1.22	N/D	1.22	.7	2.2	3.0
L-3	10/5	1510	1.488	.584	.904	2.12	.048	2.072	2.4	9.4	1.5
L-4	10/5	1600	.716	.238	.478	1.58	N/D	1.58	1.2	4.4	3.0
L-5	10/5	1500	.674	.227	.447	1.61	N/D	1.61	1.3	4.2	4.5
L-9	10/5	1425	1.418	.958	.460	1.60	N/D	1.60	1.6	8.6	3.0
L-10	10/5	1115	1.389	.811	.578	1.70	.043	1.657	2.0	7.6	3.0
L-11	10/5	1048	1.333	.862	.471	1.71	.048	1.662	1.3	7.7	3.0
L-12	10/5	1029	1.277	.787	.490	1.73	.048	1.682	1.3	7.5	10.5
L-13	10/5	1000	1.495	.954	.541	1.66	.048	1.612	1.5	7.5	7.5
L-14	10/5	1215	1.544	.849	.695	1.60	.058	1.542	1.9	6.8	6.0
L-15	10/5	1230	1.670	.759	.911	1.77	.061	1.709	1.4	6.8	4.5
L-16	10/5	1015	4.281	.798	3.483	1.78	.061	1.719	1.6	7.4	3.0
T-1	10/5	1540	.702	N/D	.702	3.56	N/D	3.56	2.1	5.4	4.5
T-2	10/5	1535	.491	N/D	.491	3.88	N/D	3.88	0.3	1.3	1.5
T-6	10/5	1145	3.230	3.23	0	L/A**	.298	L/A	6.9	16.0	----
S-6	10/5	1050	.281	N/D	.281	1.25	N/D	1.25	.3	1.2	----

TABLE V - A-3

LEHIGH RIVER STUDY

CHLOROPHYLL a DATA FOR STREAM SAMPLES

Station	L-1	L-3	L-4	L-5	L-9	L-10	L-11	L-12	L-13
Date	10/5	10/5	10/5	10/5	10/5	10/5	10/5	10/5	10/5
Time	1700	1510	1600	1500	1425	1115	1048	1029	1000
Chlorophyll a (ppb)	3.00	1.50	3.00	4.50	3.00	3.00	3.00	10.5	7.5

Station	L-14	L-15	L-16	T-1	T-2	T-6	S-6	S-7	S-8
Date	10/5	10/5	10/5	10/5	10/5	10/5	10/5	10/5	10/5
Time	1215	1230	1255	1540	1535	1145	1050	1200	1205
Chlorophyll a (ppb)	6.00	4.50	3.00	4.50	1.50	3.00	0	3.00	1.50

TABLE V - A-4

LEHIGH RIVER STUDY

PHENOL DATA FOR STREAM SAMPLES

Station	L-1	L-3	L-4	L-5	L-9	L-10	L-11	L-12	L-13
Date	10/5	10/5	10/6	10/5	10/5	10/6	10/5	10/6	10/5
Time	1700	1510	1230	1500	1425	1240	1048	1315	1000
Phenol (ppm)	.013	.034	.020	.020	.013	.006	.006	0	.013

Station	L-14	L-15	L-16	T-1	T-2	T-6	S-6	S-7	S-8
Date	10/6	10/5	10/6	10/5	10/6	10/6	10/6	10/5	10/6
Time	1140	1230	1050	1540	1210	1335	0950	1200	1325
Phenol (ppm)	.006	.013	.013	.013	.013	.027	0	.035	.041

TABLE V - A-5

LEHIGH RIVER STUDY

CYANIDE DATA FOR STREAM SAMPLES

Station	L-1	L-3	L-4	L-5	L-9	L-10	L-11	L-12	L-13
Date	10/5	10/5	10/6	10/5	10/5	10/6	10/5	10/6	10/5
Time	1700	1510	1230	1500	1425	1240	1048	1315	1000
Cyanide (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Station	L-14	L-15	L-16	T-1	T-2	T-6	S-6	S-7	S-8
Date	10/6	10/5	10/6	10/5	10/6	10/6	10/6	10/5	10/6
Time	1140	1230	1050	1540	1210	1335	0950	1200	1325
Cyanide (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	0.15	0.26

TABLE V - A-6

LEHIGH RIVER STUDY

ZINC DATA FOR STREAM SAMPLES

Station	A	B	C	D	L-1	L-3	L-4	L-9
Date	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4
Time	0930	1003	1015	1135	1650	1730	1604	1380
Zinc (ppb)	260	1870	130	420	280	160	200	260

Station	L-10	L-11	L-12	L-13	L-14	L-15	L-16	T-1
Date	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4
Time	1030	1115	1140	1200	1030	1047	1102	1750
Zinc (ppb)	260	230	220	190	240	200	240	30

Station	T-2	T-6	S-6	S-7	S-8
Date	10/4	10/4	10/4	10/4	10/4
Time	1545	----	1430	1340	1330
Zinc (ppb)	20	----	140	140	120

TABLE V - B-1

LEHIGH RIVER STUDY

EFFLUENT GRAB SAMPLE DATA

Station	Date	Time	pH (S.U.)	Temperature (°C)	D.O. (ppm)	Conductivity (μ MHOS)	Free Cl_2 (ppm)	Total Cl_2 (ppm)
Allentown STP	10/4	1200	7.35	18	5.4	1350	1.0	2.0
Allentown STP	10/5	1130	7.25	19	4.5	1400	1.6	2.4
Allentown STP	10/6	0945	7.2	19	3.8	1100	2.0	2.6
Bethlehem STP	10/4	1000	7.25	19.5	5.4	600	0.5	0.7
Bethlehem STP	10/5	0945	7.3	20.0	4.5	650	0.3	0.7
Bethlehem STP	10/6	1100	7.25	19.0	4.5	560	0.3	0.4
Bethlehem Steel #005	10/4	1145	----	23	8.12	----	---	---
Bethlehem Steel #005	10/5	1335	----	28	7.45	----	---	---
Bethlehem Steel #005	10/6	1155	7.0	24	7.87	----	---	---
Bethlehem Steel #006	10/4	1145	----	23	8.12	----	---	---
Bethlehem Steel #006	10/5	1335	----	28	7.45	----	---	---
Bethlehem Steel #006	10/6	1145	7.2	21.5	8.79	----	---	---
Bethlehem Steel #007	10/4	1450	----	22.0	8.39	----	---	---
Bethlehem Steel #007	10/5	1310	----	21	8.99	----	---	---
Bethlehem Steel #007	10/6	1135	7.1	18.5	9.79	----	---	---
Bethlehem Steel #008	10/4	1430	----	25.0	8.17	----	---	---
Bethlehem Steel #008	10/5	1255	----	26	7.95	----	---	---
Bethlehem Steel #008	10/6	1125	----	23	7.97	----	---	---
Bethlehem Steel #010	10/4	1405	----	23.0	8.58	----	---	---
Bethlehem Steel #010	10/5	1245	----	24	8.51	----	---	---
Bethlehem Steel #010	10/6	1110	----	22	8.57	----	---	---
Bethlehem Steel #012	10/4	1340	----	17	9.51	----	---	---
Bethlehem Steel #012	10/5	1230	----	17	9.80	----	---	---
Bethlehem Steel #012	10/6	1050	7.2	18	9.36	----	---	---
Bethlehem Steel #014	10/4	1320	----	20.5	8.51	----	---	---
Bethlehem Steel #014	10/5	1215	----	21	8.26	----	---	---
Bethlehem Steel #014	10/6	1035	----	20	8.97	----	---	---
Bethlehem Steel #015	10/4	1230	----	20	----	----	---	---
Bethlehem Steel #015	10/5	1120	----	20	7.42	----	---	---
Bethlehem Steel #015	10/6	1015	7.7	20.5	6.94	----	---	---
Bethlehem Steel #031	10/4	1300	----	19	0.00	----	---	---

TABLE V - B-1

LEHIGH RIVER STUDY

EFFLUENT GRAB SAMPLE DATA

Station	Date	Time	pH (S.U.)	Temperature (°C)	D.O. (ppm)	Conductivity (μ MHOS)	Free Cl_2 (ppm)	Total Cl_2 (ppm)
Bethlehem Steel #031	10/5	1100	----	19	36.491	----	---	---
Bethlehem Steel #031	10/6	1000	----	19	357.930	----	---	---
New Jersey Zinc/	10/4	1500	7.5	15	12.2	320	---	---
Saucon Creek	10/5	1430	7.3	15.2	12.2	300	---	---
300 yards above discharges	10/6	0845	7.3	12	8.0	290	---	---
New Jersey Zinc	10/4	1400	7.5	16	12.0	390	---	---
200 yards below	10/5	1345	7.3	15.2	11.5	380	---	---
outfalls	10/6	0800	7.3	14	9.4	380	---	---

TABLE V - B-2

LEHIGH RIVER STUDY

EFFLUENT COMPOSITE SAMPLE DATA

Station	Composite Period From	To	TKN-N (ppm)	NH_3-N (ppm)	Norg (ppm)	$(NO_2 + NO_3)$-N (ppm)	NO_2-N (ppm)	NO_3 (ppm)	BOD_5 (ppm)	BOD_{20} 9/31 (ppm)	pH
Allentown STP	1200 - 10/3	1200 - 10/4	32.704	11.5	21.204	3.35	.171	3.179	54	120	---
Allentown STP	1200 - 10/4	1130 - 10/5	16.842	10.3	6.542	3.15	.144	3.006	21	90	---
Allentown STP	1130 - 10/5	0945 - 10/6	15.203	11.7	3.503	2.71	.121	2.589	47	106.5	7.1
Bethlehem STP	1000 - 10/3	1000 - 10/4	19.100	19.1	0	.518	.518	.338	66	189	---
Bethlehem STP	1000 - 10/4	0945 - 10/5	36.491	18.1	18.391	.458	.105	.353	36	129	---
Bethlehem STP	0945 - 10/5	1100 - 10/6	19.926	18.1	1.826	.242	.074	.168	64.5	159	7.3
Beth. Steel #005	1430 - 10/3	1145 - 10/4	1.216	1.05	.166	1.33	.041	1.289	3.3	9.7	---
Beth. Steel #005	1145 - 10/4	1335 - 10/5	1.280	1.280	0	1.61	.045	1.565	2.4	9.8	---
Beth. Steel #005	1335 - 10/5	1155 - 10/6	1.919	1.32	.599	1.77	.056	1.714	3.6	11.2	7.0
Beth. Steel #006	1730 - 10/3	1510 - 10/4	.743	.274	.469	1.38	.054	1.326	2.6	6.3	---
Beth. Steel #006	1510 - 10/4	1320 - 10/5	.982	.332	.650	1.71	.058	1.652	2.3	5.8	---
Beth. Steel #006	1320 - 10/5	1145 - 10/6	.797	.355	.442	1.87	.072	1.798	3.2	6.4	7.2
Beth. Steel #007	1720 - 10/3	1450 - 10/4	.743	.187	.556	1.83	.052	1.778	3.1	7.1	---
Beth. Steel #007	1450 - 10/4	1310 - 10/5	.674	.268	.406	1.78	.045	1.735	2.2	5.7	---
Beth. Steel #007	1310 - 10/5	1135 - 10/6	.753	.278	.475	1.75	.049	1.701	3.6	6.6	7.1
Beth. Steel #008	1710 - 10/3	1430 - 10/4	.743	.187	.556	1.83	.052	1.778	3.4	7.2	---
Beth. Steel #008	1430 - 10/4	1255 - 10/5	.618	.157	.461	2.10	.045	2.055	2.1	5.4	---
Beth. Steel #008	1255 - 10/5	1125 - 10/6	.738	.208	.530	2.19	.056	2.134	3.5	7.5	7.4
Beth. Steel #010	1700 - 10/3	1405 - 10/4	.662	.206	.456	1.39	.050	1.340	2.9	6.9	---
Beth. Steel #010	1405 - 10/4	1245 - 10/5	.884	.187	.697	1.72	.054	1.666	1.8	5.5	---
Beth. Steel #010	1245 - 10/5	1110 - 10/6	.856	.289	.567	1.90	.063	1.837	3.4	7.0	7.3
Beth. Steel #012	1615 - 10/3	1340 - 10/4	.635	.288	.347	1.32	N/D	1.32	2.1	7.3	---
Beth. Steel #012	1340 - 10/4	1230 - 10/5	.982	.270	.712	1.60	N/D	1.60	1.6	6.1	---
Beth. Steel #012	1230 - 10/5	1050 - 10/6	.856	.350	.506	1.77	.038	1.732	3.1	8.0	7.2
Beth. Steel #014	1550 - 10/3	1320 - 10/4	.635	.204	.431	1.36	N/D	1.36	3.7	9.2	---
Beth. Steel #014	1320 - 10/4	1215 - 10/5	.842	.178	.664	1.64	N/D	1.64	1.9	5.9	---
Beth. Steel #014	1215 - 10/5	1035 - 10/6	.782	.241	.541	1.81	.052	1.81	3.4	7.6	7.2
Beth. Steel #015	1530 - 10/3	1230 - 10/4	90.036	92.2	0	.993	.223	.770	57	264	---
Beth. Steel #015	1230 - 10/4	1120 - 10/5	87.700	87.7	0	1.22	.267	.953	4.5	103.5	---
Beth. Steel #015	1120 - 10/5	1015 - 10/6	101.2	101.2	0	1.20	.292	.908	25.5	121.5	7.7
Beth. Steel #031	1540 - 10/3	1300 - 10/4	346.860	.268	78.860	N/D	N/D	N/D	241.5	1203	---

TABLE V - B-2

LEHIGH RIVER STUDY

EFFLUENT COMPOSITE SAMPLE DATA

Station	Composite Period From	To	TKN-N (ppm)	NH_3-N (ppm)	Norg (ppm)	$(NO_2 + NO_3)$-N (ppm)	NO_2-N (ppm)	NO_3-N (ppm)	BOD_6 (ppm)	BOD_{20} (ppm)	pH
Beth. Steel #031	1300 - 10/4	1100 - 10/5	332.100	.264	68.100	N/D	N/D	N/D	123	576	---
Beth. Steel #031	1100 - 10/5	1000 - 10/6	357.930	303.	54.930	N/D	N/D	N/D	121.5	510	8.6
New Jersey Zinc 200 yards below outfalls	1400 - 10/3	1400 - 10/4	.703	.088	.615	1.16	N/D	1.16	----	---	---
New Jersey Zinc/ Saucon Creek 300 yards above outfalls	GRAB	1400 - 10/4	2.460	N/D	2.460	1.76	N/D	1.76	----	---	---

TABLE V - B-3

LEHIGH RIVER STUDY

PHENOL DATA FOR EFFLUENT SAMPLES

Station	Allentown STP	Bethlehem STP	Bethlehem Steel #005	Bethlehem Steel #0
Composite} FROM	1200 10/3	1000 10/3	1430 10/3	1730 10/
Period } TO	1200 10/4	1000 10/4	1145 10/4	1510 10/
Phenol (ppm)	.161	.091	.112	.027

Station	Bethlehem Steel #007	Bethlehem Steel #008	Bethlehem Steel #010	Bethlehem Steel #0
Composite} FROM	1720 10/3	1710 10/3	1700 10/3	1615 10/
Period } TO	1450 10/4	1430 10/4	1405 10/4	1340 10/
Phenol (ppm)	.041	.034	.041	.062

Station	Bethlehem Steel #014	Bethlehem Steel #015	Bethlehem Steel #031
Composite} FROM	1550 10/3	1530 10/3	1540 10/3
Period } TO	1320 10/4	1230 10/4	1300 10/4
Phenol (ppm)	.055	.027	35.9

TABLE V - B-4

LEHIGH RIVER STUDY

CYANIDE DATA FOR EFFLUENT SAMPLES

Station		Allentown STP		Bethlehem STP		Bethlehem Steel #005		Bethlehem Steel #006	
Composite Period	FROM	1200	10/3	1000	10/3	1430	10/3	1730	10/3
	TO	1200	10/4	1000	10/4	1145	10/4	1510	10/4
Cyanide (ppm)		0.05		0.05		0.02		<0.01	

Station		Bethlehem Steel #007		Bethlehem Steel #008		Bethlehem Steel #010		Bethlehem Steel #012	
Composite Period	FROM	1720	10/3	1710	10/3	1700	10/3	1615	10/3
	TO	1450	10/4	1430	10/4	1405	10/4	1340	10/4
Cyanide (ppm)		<0.01		<0.01		<0.01		<0.01	

Station		Bethlehem Steel #014		Bethlehem Steel #015		Bethlehem Steel #031	
Composite Period	FROM	1550	10/3	1530	10/3	1540	10/3
	TO	1320	10/4	1230	10/4	1300	10/4
Cyanide (ppm)		<0.01		0.52		50.0	

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN† ppm	NH_3† ppm	NO_2† ppm	ΔNO_2† ppm	NO_3† ppm	ΔNO_3† ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
L-1	10/4	0	.676	.096	N.D.		1.16		--			
		6	.567	.132	N.D.	0	1.20	.04	3.6	3.2	0.4	.2
		12	.449	N.D.	.083	.083	1.207	.047	5.8	4.5	1.3	.5
		20	--	--	--	--	--		7.1	5.1	2.0	--
		29	.315	N.D.	N.D.	0	1.49	.33	7.8	5.3	2.5	1.5
L-3	10/4	0	1.460	.771	.054	--	2.056		0	0	0	--
		6	1.088	.338	.562	.508	2.278	.222	4.1	2.6	1.5	2.8
		12	.590	N.D.	.109	.055	3.091	1.035	8.4	4.2	4.2	4.9
		20	--	--	--	--	--		10.7		5.3	--
		29	.509	N.D.	N.D.	-.054	3.34	1.284	11.2	6.1	5.1	5.7
L-4	10/4	0	1.203	.204	N.D.	.158	1.50		--	0	0	
		6	.567	.079	.158	0	1.512	.012	1.8	1.7	0.1	.6
		12	.410	N.D.	N.D.	0	1.74	.24	3.8	2.4	1.4	1.1
		20	--	--	--	--	--	--	4.4	2.8	1.6	
		29	.303	N.D.	N.D.	0	1.79	.29	4.7	3.0	1.7	1.3
T-1	10/4	0	1.378	N.D.	N.D.	0	3.16	--	--		0	
		6	.555	N.D.	N.D.	0	3.64	.48	2.5	0.3	2.2	2.2
		12	.526	N.D.	N.D.	0	3.58	.42	4.5	3.2	1.3	
		20	--	--	--	--	--		5.4	3.9	1.5	1.9
		29	.424	N.D.	N.D.	0	3.76	.6	5.8	4.6	1.2	2.7
L-5	10/4	0	.793	.249	N.D.		1.62		0		0	
		6	.793	.125	.214	.214	1.616	-.004	3.1	2.3	.8	.7
		12	.500	N.D.	N.D.	0	1.94	.32	5.5	3.2	2.3	1.5
		20	--	--	--		--		6.1	3.7	2.4	
		29	.291	N.D.	N.D.	0	2.01	.39	6.5	3.8	2.7	1.8

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

† = reported as mg N/l

N.D. = not detectable

[illegible] = [illegible] account

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
T-2	10/4	0	.533	N.D.	N.D.		3.80		--		0	
		6	.533	.100	N.D.	0	3.92	.12	1.2	1.2	0.0	.5
		12	.487	N.D.	.081	.081	3.879	.079	2.1	1.7	0.4	.6
		20	--	--	--		--		2.6	2.0	0.6	
		29	.291	N.D.	N.D.	0	3.99	.19	2.6	1.8	0.8	.9
S-6	10/4	0	.453	.075	N.D.		1.38		--		0	
		6	.453	N.D.	.117	.117	1.363	-.017	1.9	1.5	.4	.3
		12	.449	N.D.	N.D.	0	1.52	.14	2.9	2.1	.8	.6
		20	--	--	--		--		3.6	2.4	1.2	
		29	.218	N.D.	N.D.	0	1.61	.23	3.6	2.2	1.4	1.0
S-7	10/4	0	17.028	14.3	.110		1.360		--		0	
		6	14.616	13.3	1.14	1.03	1.28	-.08	8.0	5.0	3.0	3.2
		12	12.179	11.3	4.20	4.09	1.20	-.16	17.3	6.1	11.2	13.3
		20	--	--	--		--		31.6	6.8	24.8	
		29	5.540	5.54	8.81	8.7	3.19	1.83	41.8	7.4	34.4	38.2
S-8	10/4	0	17.296	13.4	.178		1.432		--		0	
		6	13.598	12.8	1.50	-.028	1.45	.018	11.1	11.1	--	0
		12	12.821	11.6	3.74	3.562	3.73	2.298	17.7	17.7	--	22.7
		20	--				--		31.6	31.6	--	
		29	3.042	3.04	9.84	8.06	2.16	.728	42.7	11.1	31.6	31.0
L-9	10/4	0	1.338	.815	N.D.		1.51		--		0	
		6	1.133	.528	.333	.333	1.547	.037	3.3	1.6	1.7	1.3
		12	.487	N.D.	N.D.	0	2.44	.93	6.8	2.7	4.1	4.2
		20	--		--		--		7.8	3.0	4.8	
		29	.400	N.D.	N.D.	0	2.44	.93	8.0	3.2	4.8	4.2

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
L-10	10/4	0	1.284	.796	N.D.		1.47		--		0	
		6	.929	.483	.347	.347	1.563	.093	2.8	1.6	1.2	1.6
		12	.449	N.D.	N.D.	0	2.36	.89	6.3	3.6	2.7	4.0
		20	--	--	--		--		7.2	2.9	4.3	
		29	.364	N.D.	N.D.	0	2.36	.89	7.4	3.2	4.2	4.0
L-11	10/4	0	1.230	.700	N.D.		1.57		--		0	
		6	.816	.324	.394	.394	1.596	.026	2.7	1.4	1.3	1.5
		12	.487	N.D.	N.D.	0	2.20	.63	5.6	2.1	3.5	2.9
		20	--	--	--		--		6.6	2.6	4.0	--
		29	.364	N.D.	N.D.	0	2.36	.79	6.7	2.7	4.0	3.6
L-12	10/4	0	1.149	.678	.041		1.539		--		0	
		6	1.042	.595	.160	.119	1.570	.031	1.4	1.37	0.03	3.5
		12	.538	N.D.	N.D.	-.041	2.16	.612	5.1	2.1	3.0	2.6
		20	--	--	--		--		6.1	2.6	3.5	
		29	.436	N.D.	N.D.	-.041	2.18	.614	6.3	2.8	3.4	2.7
L-13	10/4	0	1.487	.804	.041		1.479		--		0	
		6	1.188	.744	.173	.132	1.527	.048	1.6	.8	0.8	.7
		12	.423	N.D.	.314	.273	1.926	.447	5.8	2.0	3.8	3.0
		20	--	--	--		--		7.1	2.5	4.6	
		29	.423	N.D.	N.D.	-.041	2.42	.941	7.3	2.5	4.8	4.2
L-14	10/4	0	1.149	.808	.052	--	1.658		--		0	
		6	1.167	.699	.186	.134	1.694	.036	1.9	1.1	.8	.6
		12	.462	N.D.	N.D.	-.052	2.52	.862	6.2	2.3	3.9	
		20	--	--	--	--	--		7.2	2.8	4.4	3.8
		29	.436	N.D.	N.D.	-.052	2.66	1.002	7.4	3.0	4.4	4.4

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
L-15	10/4	0	1.446	.707	.054		1.536		--		0	
		6	.952	.469	.293	.239	1.607	.071	1.9	1.0	0.9	1.1
		12	.493	N.D.	N.D.	-.054	2.30	.764	5.3	3.0	2.3	3.3
		20	--	--	--		--		6.3	2.3	4.0	
		29	.497	N.D.	N.D.	-.054	2.40	.864	6.5	2.7	3.8	3.8
L-16	10/4	0	1.054	.794	.056		1.524		--	--	0	
		6	1.054	.574	.303	.247	1.617	.093	2.5	1.5	1.0	1.3
		12	.410	N.D.	N.D.	-.056	2.42	.896	6.4	2.4	4.0	3.9
		20	--	--	--		--		7.6	3.0	4.6	
		29	.473	N.D.	N.D.	-.056	2.46	.936	7.9	3.3	4.6	4.1
L-1	10/5	0	.407	.050	N.D.		1.22		--		0	
		6	.358	.063	N.D.	0	1.22	0	.7	.7	0	0
		12	.358	N.D.	N.D.	0	1.24	.02	1.3	1.0	0.3	.1
		20	--	--	--		--		1.9	1.3	0.6	--
		29	.256	N.D.	N.D.	0	1.35	.13	2.2	1.5	0.7	.6
L-3	10/5	0	1.488	.584	.048		2.072		--		0	
		6	1.168	.530	.178	.13	2.202	.13	2.4	1.5	.9	1.0
		12	.800	N.D.	.562	.514	2.338	.266	6.2	3.0	3.2	3.0
		20	--	--	--		--		8.3	4.2	4.1	
		29	.385	N.D.	N.D.	-.048	3.12	1.048	9.4	5.0	4.4	4.6
L-4	10/5	0	.716	.238	N.D.		1.58		--		0	
		6	.601	.211	.088	.088	1.532	-.048	1.2	1.9	.3	.1
		12	.413	N.D.	.210	.210	1.650	.07	3.1	.5	1.6	1.0
		20	--	--	--		--		4.1	2.0	2.1	
		29	.397	N.D.	N.D.	0	1.90	.32	4.4	2.4	2.0	1.5

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
T-1	10/5	0	.702	N.D.	N.D.		3.56		--		0	
		6	.566	N.D.	N.D.	0	3.60	-.005	2.1	1.4	.6	.2
		12	.573	N.D.	.055	.055	3.695	.149	3.4	2.5	.9	.8
		20	--	--	--		--		4.8	3.4	1.4	
		29	.410	N.D.	N.D.	0	3.87	.35	5.4	5.1	1.3	1.4
L-5	10/5	0	.674	.227	N.D.		1.61		--		0	
		6	.613	.195	.095	.095	1.605	-.005	1.3	.9	.4	.3
		12	.613	N.D.	.171	.171	1.759	.149	3.1	1.6	1.5	1.3
		20	--	--	--		--		4.1	2.1	2.0	
		29	.308	N.D.	N.D.	0	1.96	.35	4.2	2.4	1.8	1.6
T-2	10/5	0	.491	N.D.	N.D.		3.88		--		0	
		6	.370	N.D.	N.D.	0	3.92	.04	0.3	.3	0.0	.2
		12	.400	N.D.	N.D.	0	4.04	.16	0.8	.5	0.3	.7
		20	--	--	--		--		1.4	.9	0.5	
		29	.333	N.D.	N.D.	0	4.09	.21	1.3	.8	0.5	1.0
S-6	10/5	0	.281	N.D.	N.D.		1.25		--		0	
		6	.231	N.D.	.047	.047	1.203	-.047	0.3	0	.3	0
		12	N.D.	N.D.	N.D.	0	1.32	.07	0.9	.4	.5	.3
		20	--	--	--		--		1.0	.7	.3	
		29	N.D.	N.D.	N.D.	0	1.33	.08	1.2	.8	.4	.4
S-7	10/5	0	13.873	12.9	.160		1.380		--		0	
		6	13.873	11.9	1.22	1.06	1.50	.12	6.3	2.9	3.4	4.2
		12	11.466	10.5	2.78	2.62	1.44	.06	12.1	4.1	8.0	9.3
		20	--	--	--		--		28.8	5.0	23.8	
		29	3.821	3.67	5.74	5.58	4.86	3.48	37.7	5.3	32.4	35.0

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
S-8	10/5	0	17.263	14.4	.157		1.183		--		0	
		6	14.451	14.0	.812	.655	1.158	-.025	9.8	7.4	2.4	2.1
		12	14.133	13.5	2.36	.79	.92	-.263	15.4	11.0	4.4	1.5
		20	--	--	--		--		32.8	14.1	18.7	
		29	5.679	5.29	9.36	7.79	1.64	.457	43.4	6.1	27.3	28.8
L-9	10/5	0	1.418	.958	N.D.		1.60		--		0	
		6	1.272	.918	.138	.138	1.582	-.018	1.6	1.1	.5	.4
		12	.413	N.D.	.863	.863	1.817	.217	6.0	1.8	4.2	4.0
		20	--	--	--		--		7.7	2.5	5.2	
		29	.372	N.D.	N.D.	0	2.74	1.14	8.6	2.9	5.7	5.2
L-10	10/5	0	1.389	.811	.043		1.657		--		0	
		6	.960	.613	.141	.098	1.749	.092	2.0	1.1	.9	.8
		12	.413	N.D.	.113	.07	2.387	.73	6.0	2.0	4.0	3.6
		20	--	--	--		--		7.0	2.6	4.4	
		29	.385	N.D.	N.D.	-.043	2.47	.813	7.6	3.0	4.6	3.6
L-11	10/5	0	1.333	.862	.048		1.662		--		0	
		6	1.225	.855	.049	.001	1.661	.001	1.3	1.0	0.3	0
		12	1.147	.866	N.D.	-.048	1.81	.148	2.7	1.8	.9	.5
		20	--	--	--		--		7.0	2.4	4.6	
		29	.474	N.D.	N.D.	-.048	2.68	1.108	7.7	2.8	4.9	4.9
L-12	10/5	0	1.277	.787	.048		1.682		--		0	
		6	1.145	.822	.073	.025	1.647	-.035	1.3	.7	.6	0
		12	1.067	.498	.272	.224	1.748	.066	3.3	1.7	1.6	1.1
		20	--	--	--		--		6.8	2.5	4.3	
		29	.577	N.D.	N.D.	-.048	2.62	.938	7.5	2.8	4.7	4.1

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD** calc ppm	NOD* TCMP ppm
L-13	10/5	0	1.495	.954	.048		1.612		--			0
		6	1.179	.877	.178	.13	1.582	-.03	1.5	.9	0.3	0.6
		12	.547	N.D.	.113	.065	2.487	.875	6.1	1.7	4.2	4.4
		20	--	--	--		--		6.9	2.5		4.4
		29	.513	N.D.	N.D.	-.048	2.63	1.038	7.5	2.8	4.6	4.7
L-14	10/5	0	1.544	.849	.058		1.542		--			0
		6	1.017	.746	.204	.146	1.686	.144	1.9	1.0	1.2	0.9
		12	.600	N.D.	.111	.053	2.529	.987	5.8	2.8	4.7	3.0
		20	--	--	--		--		6.6	2.7		3.9
		29	.436	N.D.	N.D.	-.058	2.64	1.098	6.8	3.0	4.8	3.8
L-15	10/5	0	1.670	.759	.061		1.709		--	--	0	
		6	1.040	.703	.169	.108	1.711	.002	1.4	.5	0.9	.4
		12	.493	N.D.	.171	.11	2.349	.64	5.1	1.4	3.7	3.5
		20	--	--	--		--		6.4	2.2	4.2	
		29	.474	N.D.	N.D.	-.061	2.60	.891	6.8	2.4	4.4	3.9
L-16	10/5	0	4.281	.798	.061		1.719		--			0
		6	1.318	.790	.119	.058	1.651	-.068	1.6	1.6	0	1.2
		12	.560	.042	.414	.353	2.166	.477	4.2	0.9	3.3	2.8
		20	--	--	--		--		7.0	7.0		4.9
		29	.487	N.D.	N.D.	-.061	2.62	.901	7.4	2.5	3.9	5.0
T-6	10/5	0	3.990	3.23	.298		L.A.		--			0
		6	1.861	1.18	2.16		2.88		6.9	6.9		--
		12	1.040	.280	2.21		3.47		11.4	11.4		--
		20	--	--	--		--		15.5	15.5		--
		29	.603	N.D.	N.D.		6.07		16.0		44.6	14.3

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD calc ** ppm	NOD TCMP * ppm
L-1	10/6	0	.489	N.D.	N.D.		1.26		--			0
		6	.489	N.D.	N.D.	0	1.20	-.06	1.0		0	0.0
		12	.347	N.D.	.045	.045	1.185	-.08	1.7		0	0.4
		20	--	--	--		--		2.0			0.6
		31	.229	N.D.	N.D.	0	1.31	.05	2.4	2.0	.4	0.9
L-3	10/6	0	1.181	.520	.049	L.A.	--		--			0
		6	.763	.147	.375		2.225		3.2		--	L.A.
		12	.428	N.D.	N.D.		2.79		5.8		--	
		20	--	--	--		--		6.7			
		31	.343	N.D.	N.D.		2.79		7.7		---	3.1
I-4	10/6	0	.738	.251	N.D.		1.62		--			0
		6	.565	.096	.149	.149	1.541	-.079	2.0	1.8	.2	0.5
		12	.382	N.D.	N.D.	0	1.83	.21	3.6	2.6	1.0	1.3
		20	--	--	--		--		4.2			2.3
		31	.309	N.D.	N.D.	0	1.84	.22	4.6	3.0	1.0	1.6
T-1	10/6	0	.752	N.D.	N.D.		L.A.	L.A.	--			L.A.
		6	.611	.104	.041	.158	3.249		5.4			
		12	.624	N.D.	.094	0	3.276		7.6			
		20	--	--	--		--		9.2			
		31	.343	N.D.	N.D.	0	3.37		10.2			1.8
L-5	10/6	0	.664	.237	N.D.		1.68		--			0
		6	.626	.111	.158	.158	1.612	-.068	1.9	1.7	.2	0.5
		12	.393	N.D.	N.D.	0	1.84	.16	3.8	3.1	.7	1.8
		20	--	--	--		--		4.4			1.9
		31	.331	N.D.	N.D.	0	2.00	.32	4.8	3.3	1.5	2.0

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD** calc ppm	NOD* TCMP ppm
T-2	10/6	0	.546	N.D.	N.D.		L.A.		--			0
		6	.672	.057	N.D.		3.33	-.063	4.8			L.A.
		12	.497	N.D.	.033		3.337	.04	6.6			
		20	--	--			--		7.6			
		31	.377	N.D.	N.D.		3.42	.15	8.1			1.7
S-6	10/6	0	.517	N.D.	N.D.		1.32		--			0
		6	.517	N.D.	.063	.063	1.257	-.162	2.3	2.3	0	0.6
		12	.289	N.D.	N.D.	0	1.36	.528	3.2	3.0	.2	1.0
		20	--	--	--		--		3.9			1.4
		31	N.D.	N.D.	N.D.	0	1.47	4.038	4.0	2.3	.7	1.4
S-7	10/6	0	14.760	11.3	.188		1.572		--			
		6	12.214	9.63	2.48	2.292	1.41	-.225	11.3	4.2	7.1	6.8
		12	8.208	6.14	5.00	4.812	2.10	-.531	20.8	1.9	18.9	15.2
		20	--	--	--		--		28.4			22.1
		31	2.526	1.94	5.19	5.00	5.61	.179	38.7	3.1	25.0	32.0
S-8	10/6	0	14.170	14.0	.149		1.281		--			0
		6	14.20	14.2	.344	.195	1.056	-.005	9.2	9.2	0	0.2
		12	10.80	10.8	3.84	3.691	.75	.983	23.7	13.5	10.2	9.8
		20	--	--	--		--		31.2			15.9
		31	6.210	6.21	7.40	7.251	1.46	--	41.0	16.4	24.6	24.0
L-9	10/6	0	1.461	1.05	.043		1.717		--			--
		6	.865	.676	.388	.345	1.712	-.005	3.9	2.7	1.2	0
		12	.347	N.D.	N.D.	-.043	2.70	.983	8.5	4.2	4.3	
		20	--	--	--		--		L.A.			
		31	.229	N.D.	L.A.	--	L.A.	--	L.A.		--	L.A.

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD** calc ppm	NOD* TCMP ppm
L-10	10/6	0	1.491	1.09	.056		--		--			
		6	.992	.537	.490		1.710		3.7			L.A.
		12	.439	N.D.	N.D.		2.88		8.0			
		20	--	--	--		--		8.9			
		31	L.A.	N.D.	N.D.		2.88		9.4			5.2
L-11	10/6	0	1.491	1.03	.058		1.782		--			0
		6	1.069	.719	.338	.28	1.782	0	3.2	2.2	1.0	1.0
		12	.439	N.D.	N.D.	-.058	2.64	.858	8.1	4.4	3.7	3.2
		20	--	--	--		--	--	9.2			5.2
		31	.263	N.D.	N.D.	-.058	2.64	.858	9.6	5.9	3.7	5.2
L-12	10/6	0	1.446	.963	.058		1.842		--			0
		6	.885	.404	.538	.48	1.742	-.10	3.8	2.6	1.2	1.6
		12	.439	N.D.	.094	.036	2.666	.824	7.8	3.9	3.9	3.8
		20	--	--	--		--		8.7			5.0
		31	.229	N.D.	N.D.	-.058	2.76	.918	9.2	5.2	4.0	5.0
L-13	10/6	0	1.506	.984	.058		1.832		--			0
		6	.947	.434	.531	.473	1.729	-.103	3.4	2.2	1.2	1.5
		12	.428	N.D.	.054	-.004	2.526	.694	7.6	4.4	3.2	5.0
		20	--	--	--				8.5			5.0
		31	.320	N.D.	N.D.	-.058	2.66	.828	8.3	4.7	3.6	4.7
L-14	10/6	0	1.535	1.03	.065		1.845		--			0
		6	.962	.346	.650	.585	1.850	.005	3.6	1.5	2.1	1.3
		12	.416	N.D.	N.D.	-.065	2.66	.815	8.7	5.2	3.5	4.0
		20	--		--		--		9.8			6.0
		31	N.D.	N.D.	N.D.	-.065	2.72	.875	9.7	5.9	3.8	4.7

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-1 LONG TERM BOD DATA FOR UNALTERED RIVER SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD** calc ppm	NOD* TCMP ppm
L-15	10/6	0	1.535	.917	.065		1.875		--			0
		6	.931	.323	.529	.464	1.831	-.044	4.8	3.4	1.4	1.9
		12	.566	N.D.	N.D.	-.065	2.70	.825	8.5	4.9	3.6	4.5
		20	--	--	--		--		9.6			5.0
		31	.240	N.D.	N.D.	-.065	2.70	.825	9.4	5.8	3.6	4.3
L-16	10/6	0	1.491	.957	.061		1.879		--			0
		6	1.084	.661	.342	.281	1.798	-.081	2.9	2.3	.6	0.6
		12	.486	N.D.	N.D.	-.061	2.80	.921	7.3	3.3	4.0	4.4
		20	--	--	--		--		8.1			4.6
		31	.251	N.D.	N.D.	-.061	2.80	.921	8.2	4.2	4.0	4.4
T-6	10/6	0	L.A.	6.49	.397		4.273		--			
		6	3.695	2.09	3.50	3.10	2.31	-1.96	11.7		--	
		12	.867	N.D.	4.08	3.68	4.08	- .19	21.9	10.1	11.8	
		20	--	--	--		--		26.6			
		31	.629	N.D.	N.D.	-.397	8.16	3.9	27.6	11.1	16.5	22.3

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-2

LONG TERM BOD DATA FOR SEEDED EFFLUENT SAMPLES

Station	Date	Days of Incubation		TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
AL-001	10/4	0	30	11.1	11.1	.27		4.44		--		0	
		6	30	7.29	3.15	8.4	8.13	4.89	.45	54	21	33	29.9
		12	30	L.A.	N.D.	13.74	13.47	7.26	2.82	93	30	63	59.1
		20	30	--	--	--	--	--	--	120	42	78	--
		29	30	5.46	N.D.	N.D.	-.27	21.0	16.56	120	45	75	74.3
BS-015	10/4	0	30	85.47	76.32	.45		1.41		--		0	
		6	30	83.1	83.88	9.93	9.48	2.10	.69	57	10.5	46.5	35.7
		12	30	32.16	32.16	55.53	55.08	2.67	1.26	204	15	189	194.7
		20	30	--	--	--	--	--	--	210	24	186	
		29	30	32.73	30.3	N.D.	-.45	60.6	59.19	264	15	249	269
BS-031	10/4	0	30	326.79	275.22	.12		N.D.		--		0	
		6	30	327.0	274.08	N.D.	-.12	N.D.	0	241.5	241.5	0	0
		12	30	327.48	299.46	N.D.	-.12	N.D.	0	417	417	0	0
		20	30	--	--	--		--		837	837	0	
		29	30	327	327	N.D.	-.12	N.D.	0	1203	1203	0	0
BE-001	10/4	0	30	22.59	19.92	.33		N.D.		--		0	
		6	30	12.39	7.68	12.72	12.39	2.49	2.49	99	39	60	53.9
		12	30	13.11	N.D.	21.33	21.0	4.77	4.77	120	18	102	93.8
		20	30	--	--	--		--		189	66	123	
		29	30	13.11	N.D.	N.D.	-.33	26.1	26.1	189	74	115	118.1
AL-001	10/5	0	15	19.065	10.17	.045		2.355		--		0	
		6	15	19.065	9.615	1.395	1.35	3.015	.66	21	10.5	10.5	7.6
		12	15	8.595	N.D.	11.94	11.895	4.05	1.695	64.5	16.5	48.0	48.5
		20	15	--	--	--		--	--	78	28.5	49.5	
		29	15	4.23	N.D.	N.D.	-.045	15.99	13.635	90	38	52	62

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-2 LONG TERM BOD DATA FOR SEEDED EFFLUENT SAMPLES

Station	Date	Days of Incubation	TKN† ppm	NH_3† ppm	NO_2† ppm	ΔNO_2† ppm	NO_3† ppm	ΔNO_3† ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
BS-005	10/4	0	2.105	1.05	.045		1.265					
		6	1.496	1.047	.069	.034	1.431	-.038	3.3			
		12	.731	1.70	.797	.662	1.523	.114	6.9			
		20	--	--	--		--		8.8			
		29	.388	N.D.	N.D.	-.048	2.52	1.464	9.7			
BS-006	10/4	0	.828	.259	.056		1.324		--			
		6	.737	.155	.136	.121	1.544	-.025	2.6			
		12	.410	N.D.	N.D.	.039	1.88	.367	5.0			
		20	--	--	--		--		5.6			
		29	.303	N.D.	N.D.	-.061	1.95	.517	6.3			
BS-007	10/4	0	.856	.291	.048		1.412		--			
		6	.759	.168	.160	.133	1.640	.013	3.1			
		12	.513	N.D.	N.D.	.03	2.01	.316	5.5			
		20	--	--	--		--		6.6			
		29	.303	N.D.	N.D.	-.045	2.00	.481	7.1			
BS-008	10/4	0	.856	.144	.048		1.732		--			
		6	.680	.056	.134	.087	1.866	.029	3.4			
		12	.436	N.D.	N.D.	-.045	2.30	.201	5.4			
		20	--	--	--		--		6.9			
		29	.352	N.D.	N.D.	-.045	2.30	.301	7.2			
BS-010	10/4	0	.730	.214	.048		1.362		--			
		6	.646	.091	.134	.099	1.566	-.023	2.9	2.0		.2
		12	.474	N.D.	N.D.	.007	1.82	.109	4.9	3.5		.5
		20	--	--	--		--		6.1			
		29	.303	N.D.	N.D.	-.050	1.87	.296	6.9	4.6		1.2

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

† = reported as mg N/l

N.D. = not detectable

.A. ab der

Table # V -C-2 LONG TERM BOD DATA FOR SEEDED EFFLUENT SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
BS-012	10/4	0	.702	.321	N.D.		N.D.		--			
		6	.714	.195	.112	.082	1.488	.014	2.1	1.6		.3
		12	.500	N.D.	.079	.294	1.721	.062	4.7	3.2		1.3
		20	--	--	--		--		6.2			
		29	.303	N.D.	N.D.	0	1.87	.356	7.3	4.5		1.6
BS-014	10/4	0	1.137	.246	.041		1.279		--			
		6	.623	.046	.103	.072	1.497	.014	3.7	3.3		.3
		12	.564	N.D.	.125	.102	1.585	.144	6.2	5.6		1.0
		20	--	--	--		--		9.2			
		29	.364	N.D.	N.D.	-.041	1.76	.287				1.2
BS-005	10/5	0	1.653	1.28	.048		1.576		--		0	
		6	1.280	1.28	.082	.034	1.538	-.038	2.4	2.4	.7	0
		12	1.133	.584	.710	.662	1.690	.114	8.0	5.2	4.8	2.8
		20	--	--	--		--		9.3		5.5	
		29	.397	N.D.	N.D.	-.048	3.04	1.464	9.8	3.3	5.7	6.5
BS-006	10/5	0	.871	.328	.061		1.673		--		0	
		6	.590	.205	.182	.121	1.648	-.025	2.3	2.0	.7	.3
		12	.547	N.D.	.100	.039	2.040	.367	4.3	2.5	1.6	1.8
		20	--	--	--		--		5.3		2.0	
		29	.372	N.D.	N.D.	-.061	2.19	.517	5.8	3.6	2.2	2.2
BS-007	10/5	0	.738	.296	.045		1.749		--		0	
		6	.566	.199	.178	.133	1.762	.013	2.2	1.7	.7	.5
		12	.533	N.D.	.075	.03	2.065	.316	4.4	2.9	1.6	1.5
		20	--	--	--		--		5.2	5.2	1.7	
		29	.372	N.D.	N.D.	-.045	2.23	.481	5.7	3.7	2.0	2.0

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-2 LONG TERM BOD DATA FOR SEEDED EFFLUENT SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
BS-008	10/5	0	.502	.167	.045		2.039		--		0	
		6	.486	.109	.132	.087	2.068	.029	2.1	1.7	.3	.4
		12	.486	N.D.	N.D.	-.045	2.24	.201	3.8	3.0	1.3	.8
		20	--	--	--		--		4.7		1.5	
		29	.385	N.D.	N.D.	-.045	2.34	.301	5.4	4.2	1.2	1.2
BS-010	10/5	0	.590	.216	.050		1.684		--		0	
		6	.566	.131	.149	.099	1.661	-.023	1.8	1.6	0.9	.2
		12	.507	N.D.	.057	.007	1.793	.109	3.6	3.1	1.4	.5
		20	--	--	--	--	--		4.7		1.9	
		29	.359	N.D.	N.D.	-.050	1.98	.296	5.5	4.3	2.3	1.2
BS-012	10/5	0	.605	.293	N.D.		1.584		--		0	
		6	.537	.270	.082	.082	1.598	.014	1.6	1.3	.5	.3
		12	.573	N.D.	.294	.294	1.646	.062	3.6	2.3	1.5	1.3
		20	--	--	--	--	--		5.1		2.2	
		29	.385	N.D.	N.D.	0	1.94	.356	6.1	4.5	2.8	1.6
BS-014	10/5	0	.546	.208	.041		1.593		--		0	
		6	.428	.125	.113	.072	1.607	.014	1.9	1.6	.4	.3
		12	.428	N.D.	.143	.102	1.737	.144	3.3	2.3	.6	1.0
		20	--	--	--	--	--		4.7		1.3	
		29	.385	N.D.	N.D.	-.041	1.88	.287	5.9	4.7	1.2	1.7

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-2 LONG TERM BOD DATA FOR SEEDED EFFLUENT SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
BS-005	10/6	0	1.919	1.30	.054		1.656		--		0	
		6	1.618	1.223	.177	.123	1.613	-.043	3.6	3.3	1.0	.3
		12	.728	N.D.	.764	.710	2.176	.520	8.2	3.4	4.8	4.8
		20	--	--	--		--		10.2			
		31	.331	N.D.	N.D.	-.054	2.94	1.284	11.2	5.5	6.1	5.7
BS-006	10/6	0	.886	.361	.065		1.775		--		0	
		6	.641	.119	.285	.220	1.715	-.060	3.2	2.7	1.0	.5
		12	.382	N.D.	.045	-.020	2.115	.340	4.8	3.3	1.3	1.5
		20	--	--	--		--		5.4		1.9	
		31	.263	N.D.	N.D.	-.065	2.16	.385	6.4	4.9	2.2	1.5
BS-007	10/6	0	.282	.287	.044		1.756		--		0	
		6	.458	N.D.	.224	.180	1.796	.040	3.6	2.8	1.5	.8
		12	.393	N.D.	N.D.	-.044	2.12	.364	5.0	3.5	1.3	1.5
		20	--	--	--		--		5.8		2.2	
		31	N.D.	N.D.	N.D.	-.044	2.10	.344	6.6	5.2	2.4	1.4
BS-008	10/6	0	.738	.220	.054		2.026		--		0	
		6	.458	.087	.153	.099	2.067	.041	3.5	3.0	0.4	.5
		12	.358	N.D.	N.D.	-.054	2.19	.164	5.3	4.7	0.6	.6
		20	--	--	--		--		6.3		1.6	
		31	N.D.	N.D.	N.D.	-.054	2.19	.164	7.5	6.9	2.0	.6
BS-010	10/6	0	.768	.247	.058		1.782				0	
		6	.565	.045	.206	.148	1.724	-.058	3.4	3.2	0.9	.2
		12	.312	N.D.	N.D.	-.058	1.97	.188	4.9	4.2	0.8	.7
		20	--	--	--		--		5.9		1.8	
		31	N.D.	N.D.	N.D.	-.058	1.97	.188	7.0	6.3	2.0	.7

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-2

LONG TERM BOD DATA FOR SEEDED EFFLUENT SAMPLES

Station	Date	Days of Incubation	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
BS-012	10/6	0	.738	.340	N.D.		1.66		--		0	
		6	.534	.112	.217	.217	1.683	.023	3.1	2.3	0.8	.8
		12	.393	N.D.	N.D.	0	1.97	.31	5.4	4.0	1.4	1.4
		20	--	--	--		--		6.8		2.6	
		31	N.D.	N.D.	N.D.	0	2.00	.34	8.0	6.4	2.8	1.6
BS-014	10/6	0	.679	.245	.047		1.703		--		0	
		6	.748	.071	.172	.125	1.678	-.03	3.4	3.1	0.5	.3
		12	.301	N.D.	N.D.	-.047	2.00	.297	5.1	3.9	1.5	1.2
		20	--	--	--		--		6.1		1.5	
		31	N.D.	N.D.	N.D.	-.047	1.98	.277	7.0	5.9	1.6	1.1

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V -C-3 LONG TERM BOD DATA FOR SEEDED AND DILUTED EFFLUENT SAMPLES

Sta.	Date	Days of Incub.	Dil. Fac.	TKN ppm	NH_3 ppm	NO_2 ppm	ΔNO_2 ppm	NO_3 ppm	ΔNO_3 ppm	BOD ppm	CBOD TCMP ppm	NOD* TCMP ppm	NOD** calc ppm
BS-001	10/5	0	15	97.635	86.745	.195		.825				0	
		6	15	--	85.875	1.125	.93	.825	0	4.5	1.5	3.0	3.2
		12	15	73.995	68.76	26.4	26.205	2.19	1.365	64.5	0	64.5	96.1
		20	15	--	--	--	--	--		94.5	0	94.5	
		29	15	--	77.7	14.835	14.64	13.665	12.84	103.5	0	103.5	108.9
BS-031	10/5	0	15	365.31	248.295	N.D.		N.D.				0	
		6	15	319.995	237.375	N.D.	0	N.D.	0	123	123	0	0
		12	15	319.995	255.51	N.D.	0	N.D.	0	244.5	0	0	0
		20	15	--	--	--		--	--	451.5	451.5	0	
		29	15	--	250.5	N.D.	0	N.D.	0	576	0	0	0
BE-001	10/5	0	15	38.745	18.945	.045		.330				0	
		6	15	22.365	17.625	1.515	1.47	.330	0	36	16.5	19.5	5.0
		12	15	8.595	N.D.	17.7	17.655	2.79	2.46	105	27	78	71.5
		20	15	--	--	--		--		126.0	38.2	87.8	
		29	15	5.19	N.D.	N.D.	-.04	20.85	20.52	129	48	81.0	93.6

* NOD (TCMP) = BOD-CBOD

** NOD (calc) = 3.43 (ΔNO_2+ΔNO_3) + 1.14 (ΔNO_3)

Table # V-C-4

THOMAS GRAPHICAL DETERMINATION OF BOD CONSTANTS
UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/4	L-1	6	2.45	0.4	3.6	1.23	3.2
		12	2.10	1.3	5.8	1.40	4.5
		20	2.15	2.0	7.1	1.58	5.1
		29	2.26	2.5	7.8	1.76	5.3
		All Points		Last 3 Pts		All Points	
		.213	r	.9840		.997	
		.205	m	.009		.023	
		3.64	b	1.977		1.11	
			k_{10}	.01188		.0541	
			L_o	4.73		8.04	
	L-3	6	1.59	1.5	4.1	1.32	2.6
		12	1.42	4.2	8.4	1.42	4.2
		20	1.56	5.3	10.7	1.55	5.4
		29	1.78	5.1	11.2	1.68	6.1
		.6847	r	.9956		.9994	
		.010	m	.021		.0157	
		1.417	b	1.155		1.230	
			k_{10}	.0474		.0333	
			L_o	5.95		7.02	
	L-4	6	3.91	0.1	1.8	1.52	1.7
		12	2.05	1.4	3.8	1.71	2.4
		20	2.32	1.6	4.4	1.92	2.8
		29	2.57	1.7	4.7	2.13	3.0
		-.515	r	.9984		.998	
		-.043	m	.031		.026	
		3.427	b	1.092		1.379	
			k_{10}	.0478		.0492	
			L_o	1.88		3.37	

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$		NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$		CBOD mg/l
10/4	T-1	6	1.40		2.2	2.5	2.71		0.3
		12	2.10		1.3	4.5	1.55		3.2
		20	2.37		1.5	5.4	1.72		3.9
		29	2.88		1.2	5.8	1.85		4.6
		All Points			Last 3 Pts.		All Points		
		.9728		r	.9900		-.533		
		.060		m	.046		-.028		
		1.181		b	1.513		2.420		
				k_{10}	.0985		-.0302		
				L_o	1.27		1.02		
	L-5	6	1.956		.8	3.1	1.376		2.3
		12	1.733		2.3	5.5	1.55		3.2
		20	2.02		2.4	6.1	1.75		3.7
		29	2.20		2.7	6.5	1.96		3.8
		.7373		r	.9863		.999		
		.014		m	.027		.025		
		1.739		b	1.429		1.236		
				k_{10}	.0493		.053		
				L_o	3.02		4.35		
	T-2	6	0		0	1.2	1.71		1.2
		12	3.107		.4	2.1	1.92		1.7
		20	3.21		.6	2.6	2.15		2.0
		29	3.31		0.8	2.6	2.52		1.8
		.7531		r	.9991		.997		
		.1212		m	.012		.035		
		.376		b	2.966		1.494		
				k_{10}	.0105		.0611		
				L_o	1.59		2.13		

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/4	S-6	6	2.46	0.4	1.9	1.59	1.5
		12	2.46	0.8	2.9	1.79	2.1
		20	2.55	1.2	3.6	2.03	2.4
		29	2.74	1.4	3.6	2.36	2.2
		All Points		Last 3 Pts		All Points	
		.942	r	.9857		.999	
		.012	m	.017		.033	
		2.344	b	2.246		1.387	
			k_{10}	.0198		.0621	
			L_o	1.94		2.62	
	S-7	6	1.26	3.0	8.0	1.06	5.0
		12	1.02	11.2	17.3	1.25	6.1
		20	.931	24.8	31.6	1.43	6.8
		29	.94	34.4	41.6	1.58	7.4
		-.8378	r	-.796		.990	
		-.013	m	-.004		.022	
		1.254	b	1.057		.956	
			k_{10}	-.0099		.0601	
			L_o	37.19		8.28	
	L-9	6	1.52	1.7	3.3	1.55	1.6
		12	1.43	4.1	6.8	1.64	2.7
		20	1.61	4.8	7.8	1.88	3.0
		29	1.82	4.8	8.0	2.08	3.2
		0.879	r	0.99994		0.995	
		0.015	m	0.023		0.024	
		1.349	b	1.153		1.387	
			k_{10}	0.0521		0.0452	
			L_o	5.44		3.60	

Table # V-C-4 (con't). UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/1	BOD mg/1	CBOD $(t/y)^{1/3}$	CBOD mg/1
10/4	L-10	6	1.71	1.2	2.8	1.55	1.6
		12	1.64	2.7	6.3	1.49	3.6
		20	1.67	4.3	7.2	1.90	2.9
		29	1.90	4.2	7.4	2.08	3.2
		All Points		Last 3 Pts.		All Points	
		0.725	r	0.927		0.937	
		0.008	m	0.016		0.026	
		1.588	b	1.421		1.311	
			k_{10}	0.0294		0.0518	
			L_o	5.15		3.72	
	L-11	6	1.66	1.3	2.7	1.62	1.4
		12	1.51	3.5	5.6	1.79	2.1
		20	1.71	4.0	6.6	1.97	2.6
		29	1.93	4.0	6.7	2.20	2.7
		0.804	r	0.99998		0.99993	
		0.014	m	0.025		0.025	
		1.468	b	1.214		1.478	
			k_{10}	0.0537		0.0441	
			L_o	4.52		3.05	
	L-12	6	2.71	0.03	1.4	1.76	1.1
		12	1.59	3.0	5.1	1.79	2.1
		20	1.79	3.5	6.1	1.97	2.6
		29	2.04	3.4	6.3	2.15	2.9
		-0.402	r	0.9995		0.983	
		-0.020	m	0.026		0.018	
		2.362	b	1.268		1.619	
			k_{10}	0.0535		0.0290	
			L_o	3.99		3.53	

Table # V-C-4 (con't). UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/4	L-13	6	1.96	0.8	1.6	1.96	0.8
		12	1.47	3.8	5.8	1.82	2.0
		20	1.63	4.6	7.1	2.0	2.5
		29	1.82	4.8	7.3	2.26	2.5
		All Points		Last 3 Pts.		All Points	
		-0.072	r	0.9999		0.813	
		-0.002	m	0.021		0.015	
		1.746	b	1.221		1.76	
			k_{10}	0.449		0.0222	
			L_o	5.32		3.59	
	L-14	6	1.96	0.8	1.9	1.76	1.1
		12	1.45	3.9	6.2	1.73	2.3
		20	1.66	4.4	7.2	1.92	2.8
		29	1.87	4.4	7.4	2.13	3.0
		.051	r	0.9994		0.946	
		.001	m	0.025		0.017	
		1.716	b	1.158		1.59	
			k_{10}	0.0563		0.0279	
			L_o	4.97		3.88	
	L-15	6	1.88	0.9	1.9	1.82	1.0
		12	1.73	2.3	5.3	1.59	3.0
		20	1.71	4.0	6.3	2.05	2.3
		29	1.97	3.8	6.5	2.20	2.7
		.340	r	0.848		0.812	
		.004	m	0.014		0.022	
		1.752	b	1.510		1.55	
			k_{10}	0.0242		0.0370	
			L_o	5.22		3.16	

Table # V-C-4 (con't). UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/4	L-16	6	1.81	1.0	2.5	1.59	1.5
		12	1.44	4.0	6.4	1.71	2.4
		20	1.63	4.6	7.6	1.88	3.0
		29	1.85	4.6	7.9	2.06	3.3
		All Points		Last 3 Pts.		All Points	
		.296	r	0.99997		0.99992	
		.006	m	0.024		0.021	
		1.589	b	1.149		1.466	
			k_{10}	0.0545		0.0374	
			L_o	5.26		3.69	
10/5	L-1	6	0	0	0.7	2.05	0.7
		12	3.42	0.3	1.3	2.29	1.0
		20	3.21	0.6	1.9	2.48	1.3
		29	3.46	0.7	2.2	2.68	1.5
		.182	r	.7249		.991	
		.003	m	.122			
		3.30	b	.472			
			k_{10}	.0024		.0366	
			L_o	5.04		1.66	
	L-3	6	1.88	.9	2.4	1.59	1.5
		12	1.55	3.2	6.2	1.59	3.0
		20	1.70	4.1	8.3	1.68	4.2
		29	1.87	4.4	9.4	1.80	5.0
		.1832	r	.9999		.962	
		.003	m	.019		.010	
		1.702	b	1.324		1.504	
			k_{10}	.0374		.0174	
			L_o	5.01		7.34	

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD (t/y) $^{1/3}$	NOD mg/l	BOD mg/l	CBOD (t/y) $^{1/3}$	CBOD mg/l
10/5	L-4	6	2.71	.3	1.2	1.88	0.9
		12	1.96	1.6	3.1	2.00	1.5
		20	2.12	2.1	4.1	2.15	2.0
		29	1.13	2.0	4.4	2.29	2.4
		All Points		Last 3 Pts		All Points	
		-.9073	r	-.8016		.998	
		-.059	m	-.050		.018	
		2.973	b	2.76		1.781	
			k_{10}	-.0473		.0264	
			L_o	9.19		2.92	
	T-1	6	2.15	0.6	2.1	1.59	1.5
		12	2.37	0.9	3.4	1.69	2.5
		20	2.42	1.4	4.8	1.80	3.4
		29	2.81	1.3	5.4	1.92	4.1
		.9630	r	.9265		.9988	
		.026	m	.026		.014	
		1.99	b	2.00		1.512	
			k_{10}	.0339		.0242	
			L_o	1.60		5.20	
	L-5	6	2.46	0.4	1.3	1.88	0.9
		12	2.00	1.5	3.1	1.96	1.6
		20	2.15	2.0	4.1	2.12	2.1
		29	2.52	1.8	4.2	2.29	2.4
		.2571	r	.9789		.998	
		.006	m	.031		.018	
		2.175	b	1.597		1.758	
			k_{10}	.0507		.0267	
			L_o	2.11		3.00	

Table # V-C-4 (con't). UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/1	BOD mg/1	CBOD $(t/y)^{1/3}$	CBOD mg/1
10/5	T-2	6	0	0	0.3	2.71	0.3
		12	3.42	.3	0.8	2.88	0.5
		20	3.42	.5	1.4	2.81	0.9
		29	3.87	.5	1.5	3.31	0.8
		All Points		Last 3 Pts		All Points	
		.7956	r	.8825		.863	
		.142	m	.27		.025	
		.307	b	3.022		2.54	
			k_{10}	.0233		.0236	
			L_o	0.68		1.12	
	S-6	6	2.71	0.5	.3		
		12	2.88	0.5	.9	3.10	.4
		20	4.05	0.3	1.0	3.05	.7
		29	3.87	0.5	1.2	3.46	.7
		.8721	r	.7643		.824	
		.059	m	.057		.022	
		2.382	b	2.449		2.76	
			k_{10}	.0607		.0208	
			L_o	.49		.99	
	S-7	6	1.21	3.4	6.3	1.27	2.9
		12	1.14	8.0	12.1	1.45	4.1
		20	.94	23.8	28.8	1.59	5.0
		29	.96	32.4	57.7	1.76	5.3
		-.9042	r	-.7970		.997	
		-.012	m	-.010		.021	
		1.265	b	1.223		1.160	
			k_{10}	-.0213		.0473	
			L_o	11.16		5.89	

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD (t/y) 1/3	NOD mg/l	BOD mg/l	CBOD (t/y) 1/3	CBOD mg/l
10/5	S-8	6	1.36	2.4	9.8	0.933	7.4
		12	1.40	4.4	15.4	1.03	11.0
		20	1.02	18.7	32.8	1.12	14.1
		29	1.02	27.3	43.4	1.22	16.1
		All Points		Last 3 Pts		All Points	
		-0.8747	r	0.8486		0.996	
		-0.0183	m	0.0219		0.012	
		1.5061	b	1.5918		0.870	
			k_{10}	0.0359		0.036	
			L_o	3.00		18.34	
	L-9	6	2.29	0.5	1.6	1.76	1.1
		12	1.42	4.2	6.0	1.88	1.8
		20	1.57	5.2	7.7	2.0	2.5
		29	1.72	5.7	8.6	2.15	2.9
		-0.4559	r	0.9994		0.999	
		-0.0174	m	0.0176		0.017	
		2.0416	b	1.2116		1.67	
			k_{10}	0.0379		0.0266	
			L_o	6.45		3.51	
	L-10	6	1.88	0.9	2.0	1.76	1.1
		12	1.44	4.0	6.0	1.82	2.0
		20	1.66	4.4	7.0	1.97	2.6
		29	1.85	4.6	7.6	2.13	3.0
		0.1656	r	.9971		0.995	
		0.0034	m	.0241		0.017	
		1.6510	b	1.1609		1.64	
			k_{10}	.054		0.0271	
			L_o	5.16		2.64	

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD (t/y) $^{1/3}$	NOD mg/l	BOD mg/l	CBOD (t/y) $^{1/3}$	CBOD mg/l
10/5	L-11	6	2.71	0.3	1.3	1.82	1.0
		12	2.37	0.9	2.7	1.88	1.8
		20	1.63	4.6	7.0	2.03	2.4
		29	1.81	4.9	7.7	2.18	2.8
		All Points		Last 3 Pts.		All Points	
		-0.8652	r	-0.7018		0.995	
		-0.0432	m	-0.0318		0.016	
		2.8543	b	2.5841		1.71	
			k_{10}	-0.0321		0.0244	
			L_o	5.38		3.56	
	L-12	6	2.15	0.6	1.3	2.04	0.7
		12	1.96	1.6	3.3	1.92	1.7
		20	1.67	4.3	6.8	2.0	2.5
		29	1.83	4.7	7.5	2.18	2.8
		-0.752	r	-0.416		0.662	
		-0.015	m	-0.007		0.007	
		2.159	b	1.965		1.91	
			k_{10}	-0.0093		0.0242	
			L_o	6.16		3.48	
	L-13	6	2.15	0.6	1.5	1.88	0.9
		12	1.40	4.4	6.1	1.92	1.7
		20	1.66	4.4	6.9	2.0	2.5
		29	1.83	4.7	7.5	2.18	2.8
		-0.2072	r	0.988		0.973	
		-0.007	m	0.025		0.013	
		1.868	b	1.118		1.78	
			k_{10}	0.0584		0.0191	
			L_o	5.33		4.04	

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/5	L-14	6	1.88	0.9	1.9	1.82	1.0
		12	1.59	3.0	5.8	1.62	2.8
		20	1.72	3.9	6.6	1.95	2.7
		29	1.97	3.8	6.8	2.13	3.0
		All Points		Last 3 Pts.		All Points	
		0.388	r	0.989		0.803	
		0.0066	m	0.022		0.017	
		1.680	b	1.303		1.59	
			k_{10}	0.0441		0.0414	
			L_o	4.46		3.44	
	L-15	6	1.88	0.9	1.4	2.29	0.5
		12	1.47	3.7	5.1	2.05	1.4
		20	1.68	4.2	6.4	2.09	2.2
		29	1.87	4.4	6.8	2.29	2.4
		0.203	r	0.998		0.128	
		0.00393	m	0.023		0.002	
		1.659	b	1.20		2.15	
			k_{10}	0.0500		0.0024	
			L_o	5.03		18.23	
	L-16	6	1.71	1.2	1.6	2.46	0.4
		12	1.62	2.8	4.2	2.05	1.4
		20	1.60	4.9	7.0	2.12	2.1
		29	1.80	5.0	7.4	2.29	2.4
		.4267	r	.8362		-.386	
		.0039	m	.0108		.006	
		1.6168	b	1.4531		2.317	
			k_{10}	.0194		-.0068	
			L_o	7.3043		5.14	

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/6	L-1	6	--	0	1.0	1.82	1.0
		12	3.10	.4	1.7	2.10	1.3
		20	3.21	.6	2.0	2.42	1.4
		31	3.25	.9	2.4	2.74	1.5
		All Points		Last 3 Pts.		All Points	
			r	.9380		.994	
		--	m	.0076		.036	
			b	3.026		1.64	
			k_{10}	.066		.0573	
			L_o	2.38		1.72	
	L-4	6	2.29	.5	3.2	1.30	2.7
		12	2.10	1.3	5.8	1.39	4.5
		20	1.92	2.8	6.7	1.72	3.9
		31	2.68	1.6	7.7	1.72	6.1
		.5060	r	.7892		.906	
		.0152	m	.0328		.018	
		1.9848	b	1.5433		1.215	
			k_{10}	.0555		.0387	
			L_o	2.13		6.26	
	L-5	6	2.29	.5	1.9	1.62	1.4
		12	1.88	1.8	3.8	1.82	2.0
		20	2.19	1.9	4.4	2.00	2.5
		31	2.49	2.0	4.8	2.23	2.8
		.5608	r	.9950		.995	
		.0132	m	.0318		.024	
		1.9849	b	1.5186		1.505	
			k_{10}	.0547		.0416	
			L_o	2.27		3.01	

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/6	S-6	6	2.15	.6	2.3	1.52	1.7
		12	2.29	1.0	3.2	1.76	2.2
		20	2.42	1.4	3.9	2.00	2.5
		31	2.80	1.4	4.0	2.28	2.6
		All Points		Last 3 Pts.		All Points	
		.987	r	.983		.995	
		.026	m	.027		.030	
		1.98	b	1.93		1.373	
			k_{10}	.0365		.0570	
			L_o	1.66		2.95	
	S-7	6	.959	6.8	11.3	1.10	4.5
		12	.924	15.2	20.8	1.29	5.6
		20	.967	22.1	28.4	1.47	6.3
		31	.989	32.0	38.7	1.46	6.7
		.706	r	.962		.880	
		.0018	m	.003		.014	
		.929	b	.890		1.086	
			k_{10}	.0088		.0336	
			L_o	70.08		10.10	
	S-8	6	3.10	0.2	9.2	.874	9.0
		12	1.07	9.8	23.7	.952	13.9
		20	1.08	15.9	31.2	1.09	15.3
		31	1.09	24.0	41.1	1.07	17.1
		-.687	r	.996		.871	
		-.064	m	.001		.008	
		2.69	b	1.058		.855	
			k_{10}	.025		.0244	
			L_o	24.7		28.51	

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/1	BOD mg/1	CBOD $(t/y)^{1/3}$	CBOD mg/1
10/6	L-11	6	1.82	1.0	3.7	1.30	2.7
		12	1.55	3.2	8.0	1.36	4.8
		20	1.57	5.2	8.9	1.75	5.7
		31	1.81	5.2	9.4	1.71	4.2
		All Points		Last 3 Pts		All Points	
		.124	r	.955		.869	
		.0017	m	.014		.019	
		1.658	b	1.346		1.207	
			k_{10}	.0271		.0411	
			L_o	6.58		6.02	
	L-12	6	1.55	1.6	3.8	1.40	2.2
		12	1.47	3.8	7.8	1.44	4.0
		20	1.59	5.0	8.7	1.75	5.7
		31	1.84	5.0	9.2	1.98	4.2
		.8722	r	.9940		.982	
		.0129	m	.0196		.025	
		1.3903	b	1.2202		1.213	
			k_{10}	.0419		.0538	
			L_o	5.71		4.53	
	L-13	6	1.59	1.5	3.4	1.47	1.9
		12	1.34	5.0	7.6	1.66	2.6
		20	1.59	5.0	8.5	1.79	3.5
		31	1.87	4.7	8.3	2.05	3.6
		.7349	r	.9983		.995	
		.0147	m	.0277		.022	
		1.3436	b	1.0173		1.356	
			k_{10}	.0711		.0423	
			L_o	5.81		4.12	

Table # V-C-4 (con't) UNALTERED RIVER SAMPLES

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/1	BOD mg/1	CBOD $(t/y)^{1/3}$	CBOD mg/1
10/6	L-14	6	1.66	1.3	3.6	1.38	2.3
		12	1.44	4.0	8.7	1.37	4.7
		20	1.49	6.0	9.8	1.74	3.8
		31	1.87	4.7	9.7	1.84	5.0
		All Points		Last 3 Pts		All Points	
		.5671	r	.9473		.934	
		.0102	m	.0234		.021	
		1.4392	b	1.1096		1.220	
			k_{10}	.0550		.0449	
			L_o	5.79		5.33	
	L-15	6	1.47	1.9	4.8	1.27	2.9
		12	1.39	4.5	8.5	1.44	4.0
		20	1.59	5.0	9.6	1.63	4.6
		31	1.93	4.3	9.5	1.81	5.2
		.9165	r	.9983		.992	
		.0202	m	.0286		.021	
		1.2470	b	1.0367		1.168	
			k_{10}	.0720		.0469	
			L_o	5.42		5.82	
	L-16	6	2.15	.6	2.9	1.38	2.3
		12	1.400	4.4	7.3	1.60	2.9
		20	1.631	4.6	8.1	1.79	3.5
		31	1.916	4.4	8.2	2.01	3.8
		-.0666	r	.9995		.991	
		-.0020	m	.0270		.025	
		1.809	b	1.080		1.270	
			k_{10}	.065		.0514	
			L_o	5.31		4.13	

Table # V-C-5

THOMAS GRAPHICAL DETERMINATION OF BOD CONSTANTS
SEEDED EFFLUENT SAMPLES
Industrial Effluents

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/5	BS-005	6	2.04	.7	2.4	1.52	1.7
		12	1.36	4.8	8.0	1.55	3.2
		20	1.76	5.5	9.3	1.74	3.8
		29	1.72	5.7	9.8	1.92	4.1
		All Points		Last 3 Pts.		All Points	
		-.1915	r	.7970		.9833	
		-.0054	m	.0206		.0183	
		1.8097	b	1.1935		1.3757	
			k_{10}	.0450		.0347	
			L_o	5.68		4.81	
	BS-006	6	2.04	.7	2.3	1.55	1.6
		12	2.00	1.6	4.3	1.64	2.7
		20	2.15	2.0	5.3	1.82	3.3
		29	2.36	2.2	5.8	2.00	3.6
		.9250	r	.9981		.9509	
		.0150	m	.0212		.0318	
		1.8870	b	1.7385		1.1368	
			k_{10}	.0318		.0730	
			L_o	2.60		4.05	
	BS-007	6	2.04	0.7	2.2	1.59	1.5
		12	2.00	1.6	4.4	1.62	2.8
		20	2.27	1.7	5.2	1.79	3.5
		29	2.44	2.0	5.7	1.99	3.7
		.9459	r	.9865		.9812	
		.0195	m	.0257		.0181	
		1.8602	b	1.7133		1.4443	
			k_{10}	.0392		.0413	
			L_o	2.21		3.50	

Table # V-C-5 (con't)

SEEDED EFFLUENT SAMPLES
Industrial Effluents

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/5	BS-008	6	2.71	.3	2.1	1.49	1.8
		12	2.10	1.3	3.8	1.69	2.5
		20	2.37	1.5	4.7	1.84	3.2
		29	2.52	1.8	5.4	2.00	3.6
		All Points		Last 3 Pts.		All Points	
		-.0695	r	.9806		.9890	
		-.0018	m	.0245		.0215	
		2.4550	b	1.8310		1.3942	
			k_{10}	.0349		.0402	
			L_o	2.03		3.99	
	BS-010	6	1.88	.9	1.8	1.88	.9
		12	2.04	1.4	3.6	1.76	2.2
		20	2.19	1.9	4.7	1.92	2.8
		29	2.33	2.3	5.5	2.08	3.2
		All Points		Last 3 Pts.		All Points	
		.993	r	.999		.7961	
		.019	m	.017		.0105	
		1.787	b	1.841		1.7333	
			k_{10}	.0241		.0158	
			L_o	2.89		5.20	
	BS-012	6	2.29	.5	1.6	1.76	1.1
		12	2.00	1.5	3.6	1.79	2.1
		20	2.09	2.2	5.1	1.90	2.9
		29	2.18	2.8	6.1	2.06	3.3
		-.167	r	.9994		.9812	
		-.002	m	.0106		.0133	
		2.175	b	1.875		1.6539	
			k_{10}	.0148		.0210	
			L_o	4.46		4.58	

Table # V-C-5 (con't) · SEEDED EFFLUENT SAMPLES
Industrial Effluents

Date	Station	Days of Incubation	NOD (t/y) $^{1/3}$	NOD mg/l	BOD mg/l	CBOD (t/y) $^{1/3}$	CBOD mg/l
10/5	BS-014	6	2.46	.4	1.9	1.59	1.5
		12	2.71	.6	3.3	1.64	2.7
		20	2.48	1.3	4.7	1.80	3.4
		29	2.57	1.7	5.9	1.90	4.2
		All Points		Last 3 Pts.		All Points	
		.0660	r	-.577		.9900	
		.0008	m	-.008		.0142	
		2.54	b	2.746		1.495	
			k_{10}	.0076		.0243	
			L_o	2.76		5.25	
10/6	BS-005	6	1.82	1.0	3.6	1.32	2.6
		12	1.36	4.8	8.2	1.52	3.4
		20	1.54	5.5	10.2	1.62	4.7
		31	1.72	6.1	11.2	1.82	5.1
		.041	r	.996		.9848	
		.00076	m	.019		.0190	
		1.597	b	1.145		1.2430	
			k_{10}	.0433		.0399	
			L_o	6.69		5.67	
	BS-006	6	1.82	1.0	3.2	1.40	2.2
		12	2.10	1.3	4.8	1.51	3.5
		20	2.19	1.9	5.4	1.79	3.5
		31	2.41	2.2	6.4	1.94	4.2
		.96673	r	.98927		.9821	
		.02184	m	.01654		.0226	
		1.7533	b	1.88602		1.2705	
			k_{10}	.060		.0464	
			L_o	1.08		4.57	

Table # V-C-5 (con't)

SEEDED EFFLUENT SAMPLES
Industrial Effluents

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$	NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/6	BS-007	6	1.59	1.5	3.6	1.42	2.1
		12	2.10	1.3	5.0	1.48	3.7
		20	2.08	2.2	5.8	1.77	5.6
		31	2.34	2.4	6.6	1.94	4.2
		All Points		Last 3 Pts		All Points	
		.87996	r	.87669		.9306	
		.02561	m	.01330		.0222	
		1.58573	b	1.89410		1.2690	
			k_{10}	.0183		.0457	
			L_o	3.50		4.66	
	BS-008	6	2.46	.4	3.5	1.24	3.1
		12	2.71	.6	5.3	1.37	4.7
		20	2.32	1.6	6.3	1.62	4.7
		31	2.49	2.0	7.5	1.78	5.5
		-.24552	r	-.48518		.9875	
		-0.00366	m	-.00994		.0222	
		2.5582	b	2.71551		1.120	
			k_{10}	.0096		.0517	
			L_o	2.26		5.99	
	BS-010	6	1.88	.9	3.4	1.34	2.5
		12	2.46	.8	4.9	1.43	4.1
		20	2.23	1.8	5.9	1.70	4.1
		31	2.49	2.0	7.0	1.84	5.0
		.6899	r	.19530		.9805	
		.01798	m	.00291		.0211	
		1.95492	b	2.33218		1.2139	
			k_{10}	.0032		.0454	
			L_o	10.71		5.35	

Table # V-C-5 (con't)

SEEDED EFFLUENT SAMPLES
Industrial Effluents

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$		NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
10/6	BS-012	6	1.96		.8	3.1	1.38	2.3
		12	2.04		1.4	5.4	1.44	4.0
		20	1.97		2.6	6.8	1.68	4.2
		31	2.23		2.8	8.0	1.81	5.2
		All Points			Last 3 Pts.		All Points	
		.81769		r	.76750		.9799	
		.00946		m	.01082		.0183	
		1.88672		b	1.85269		1.2616	
				k_{10}	.0152		.0379	
				L_o	4.50		5.73	
	BS-014	6	2.29		.5	3.4	1.27	2.9
		12	2.00		1.5	5.1	1.49	3.6
		20	2.37		1.5	6.1	1.63	4.6
		31	2.68		1.6	7.0	1.79	5.4
		.7834		r	.98996		.9764	
		.0203		m	.03533		.0199	
		1.98557		b	1.60803		1.2015	
				k_{10}	.0573		.0432	
				L_o	1.82		5.80	

Table # V-C-6

THOMAS GRAPHICAL DETERMINATION OF BOD CONSTANTS
SEEDED & DILUTED EFFLUENT SAMPLES
STP Effluents & Industrial Effluents

Date	Station	Days of Incubation	NOD $(t/y)^{1/3}$		NOD mg/l	BOD mg/l	CBOD $(t/y)^{1/3}$	CBOD mg/l
1 4	Allentown STP	6	0.57		33	54	0.66	21
		12	0.58		63	93	0.74	30
		20	0.64		78	120	0.78	42
		29	0.75		75	120	0.840	45
		All Points			Last 3 Pts		All Points	
		0.97275		r	0.99672		0.9800	
		0.00716		m	0.00885		0.0074	
		0.51002		b	0.47009		0.6308	
				k_{10}	0.0491		0.0306	
				L_o	85.2		56.61	
	BS-015	6	0.50		46.5	57	0.83	10.5
		12	0.40		189	204	0.93	15
		20	0.48		186	210	0.94	24
		29	0.49		249	264	1.24	15
		0.20998		r	0.89782		0.9251	
		0.00096		m	0.00521		0.0164	
		0.45138		b	0.35078		0.7100	
				k_{10}	0.0388		0.0603	
				L_o	259.08		20.14	
	BS-031	6			0	241.5	.29	241.5
		12			0	417.0	.31	417.0
		20			0	837	.288	837.0
		29			0	1203.0	.29	1203.0
				r			-0.5173	
				m			-0.0003	Linear
				b			.3003	(r=.996)
				k_{10}			-0.0026	
				L_o			-6174.94	

Table # V-C-6 (con't)

SEEDED & DILUTED EFFLUENT SAMPLES
STP Effluents & Industrial Effluents

Date	Station	Days of Incubation	NOD (t/y) $^{1/3}$	NOD mg/l	BOD mg/l	CBOD (t/y) $^{1/3}$	CBOD mg/l
10/4	Bethlehem STP	6	0.46	60	99	0.54	39
		12	0.46	102	120	.874	18
		20	0.55	123	189	0.672	66
		29	0.65	115	189	0.75	74
		All Points		Last 3 Pts		All Points	
		0.96920	r	0.99770		-0.1559	
		0.00795	m	0.00998		-0.0075	Linear
		0.39184	b	0.34380		1.0081	(r=.80)
			k_{10}	0.0758			
			L_o	141.15			
10/5	Allentown STP	6	0.83	10.5	21	0.83	10.5
		12	0.63	48	64.5	0.90	16.5
		20	0.74	49.5	78	0.80	38.5
		29	0.82	52	90	0.91	38
		0.19308	r	0.99222		0.3431	
		0.00179	m	0.01113		0.0018	Linear
		0.72500	b	0.50371		0.8292	(r=.920)
			k_{10}	0.058			
			L_o				
	BS-015	6	1.26	3.0	4.5	1.59	1.5
		12	0.57	64.5	64.5	0	0
		20	0.60	94.5	94.5	0	0
		29	0.65	103.5	103.5	0	0
		-0.64501	r	0.99402		-0.8325	
		-0.02122	m	0.00472		-0.0972	(≈No growth)
		1.12546	b	0.51062		1.8073	
			k_{10}	0.0241			
			L_o	135.51			

Table # V-C-6 (con't)

SEEDED & DILUTED EFFLUENT SAMPLES
STP Effluents & Industrial Effluents

Date	Station	Days of Incubation	NOD (t/y) 1/3	NOD mg/l	BOD mg/l	CBOD (t/y) 1/3	CBOD mg/l
1/5	BS-031	6		0	123	0.36	123.0
		12		0	244.5	0.37	244.5
		20		0	451.5	0.35	451.5
		29		0	576	0.37	576.0
		All Points		Last 3 Pts		All Points	
			r			0.1483	
			m			0.0001	Linear
			b			0.3601	(r=.992)
			k_{10}				
			L_o				
	Bethlehem STP	6	0.68	19.5	36	0.36	16.5
		12	0.54	78	105	0.76	27
		20	0.61	87.8	126	0.81	38.2
		29	0.71	81.8	129	0.85	47.2
		0.35409	r	0.99772		0.8212	
		0.00260	m	0.01002		0.0186	
		0.58987	b	0.41620		0.3830	
			k_{10}	0.0628		0.127	
			L_o	96.03		60.94	
1/6	Allentown STP	6	.57	32.0	47.0	.74	15.0
		12	.60	55.5	79.5	.79	24.0
		20	.68	64.5	102	.53	37.5
		31	.80	60.0	106.5	.87	46.5
		.99230	r	.99971		.2011	
		.00943	m	.01055		.0027	Linear
		.49984	b	.47179		.6859	(r=.987)
			k_{10}	.0584		.0103	
			L_o	70.89		130.81	

Table # V-C-6 (con't)

SEEDED & DILUTED EFFLUENT SAMPLES
STP Effluents & Industrial Effluents

Date	Station	Days of Incubation	NOD (t/y) 1/3	NOD mg/l	BOD mg/l	CBOD (t/y) 1/3	CBOD mg/l
10/6	BS-015	6	.62	25.5	25.5	0	0
		12	.53	81.8	88.5	1.18	7.3
		20	.62	81.8	88.5	1.47	6.3
		31	.64	115.5	121.5	1.73	6.0
		All Points		Last 3 Pts		All Points	
		.46795	r	.90347		.8732	
		.00213	m	.00555		.0617	
		.56574	b	.48013		.0310	
			k_{10}	.0302		5.19	
			L_o	130.07		2812.03	
	BS-031	6	0	0	121.5	.05	121.5
		12	0	0	256.5	.05	256.5
		20	0	0	366	.38	366
		31	0	0	510	.39	510
			r	0		.8896	
			m	0		.0159	Linear
			b	0		-.0570	(r=.992)
			k_{10}	0		-.728	
			L_o	0			
	Bethelem STP	6	.54	39.0	64.5	.62	25.5
		12	.53	81.0	117.0	.69	36.0
		20	.61	90.0	144.0	.72	54.0
		31	.68	99.0	159.0	.80	60.0
		.95892	r	.99164		.9851	
		.00619	m	.00780		.0068	
		.48328	b	.44280		.5905	
			k_{10}	.0460		.0301	
			L_o	108.85		70.22	

r = correlation coefficient
m = slope
b = y-intercept
k_{10} = deoxygenation constant, day^{-1}, base 10
L_o = initial remaining demand, mg/l

COMPILATION OF CBOD RIVER SAMPLE KINETICS

Table # V-C-7

Station	k_{10} (day^{-1}) 10/4	10/5	10/6	L_o (mg/l) 10/4	10/5	10/6	r (coefficient of correlation) 10/4	10/5	10/6
L-1	.054	.037	.057	8.0	1.2	1.7	.997	.991	.994
L-3	.033	.017	--	7.0	7.5	--	.999	.962	--
L-4	.049	.026	.039	3.4	2.9	6.3	.998	.998	.906
T-1	-.030*	.024	--	1.02	5.2	--	(-.533)	.999	--
L-5	.053	.027	.042	4.4	3.0	3.0	.999	.998	.995
T-2	.061	.024	--	2.1	1.1	--	.997	.868	--
S-6	.062	.021	.057	2.6	1.0	3.0	.999	.824	.995
S-7	.060	.047	.034	8.3	5.9	10.1	.990	.997	.880
S-8	--	.036	.024	--	18.3	28.5	--	.996	.871
L-9	.045	.027	--	3.6	3.5	--	.995	.999	--
L-10	.052	.027	--	3.7	2.6	--	.937	.995	--
L-11	.044	.024	.041	3.1	3.6	6.0	1.000	.995	.869
L-12	.029	.024*	.054	3.5	3.5	4.5	.983	.662	.982
L-13	.022	.019	.043	3.6	4.0	4.1	.813	.973	.995
L-14	.028	.041	.045	3.9	3.4	5.3	.946	.803	.934
L-15	.037	.002*	.047	3.2	18.2	5.8	.812	.128	.992
L-16	.037	-.007*	.051	3.7	5.1	4.1	1.000	(-.386)	.991

n	15	14	12
k_{10} (day^{-1})	.044	.028	.045
s_{10}	.013	.009	.010
k_e (day^{-1})	.101	.064	.104
s_e	.030	.021	.023

Overall
n = 41
k_{10} = .039, k_e = .090
s_{10} = .011, s_e = .025

* Excluded from calculation of average k.

COMPILATION OF NOD RIVER SAMPLE KINETICS

Table # V-C-8

Station	k_{10} (day^{-1}) 10/4	10/5	10/6	L_o (mg/l) 10/4	10/5	10/6	r**(coefficient of correlation) 10/4	10/5	10/6
L-1	.012	.002	.007	4.7	5.0	2.4	.984	.725	.938
L-3	.047	.037	--	6.0	5.0	--	.996	1.000	--
L-4	.048	-.047*	.056	1.9	9.2	2.1	.998	-.802	.789
T-1	.099	.034	--	1.3	1.6	--	.990	.927	--
L-5	.049	.051	.055	3.0	2.1	2.3	.986	.979	.995
T-2	.011	.023	--	1.6	0.7	--	.999	.883	--
S-6	.020	.061	.037	1.9	0.5	1.7	.986	.764	.983
S-7	-.010*	-.023*	.009	37.4	11.2	70.1	-.796	-.797	.962
S-8	--	.036	.025	--	3.0	24.7	--	.849	.996
L-9	.052	.038	--	5.4	6.5	--	1.000	.999	--
L-10	.054	.054	--	5.2	5.2	--	.927	.997	--
L-11	.054	-.032*	.027	4.5	5.4	6.6	1.000	-.702	.935
L-12	.045	-.010*	.042	4.0	6.2	5.7	1.000	-.416	.994
L-13	.056	.058	.071	5.3	5.3	5.8	1.000	.988	.998
L-14	.024	.044	.055	5.0	4.5	5.8	.999	.989	.947
L-15	.024	.050	.072	5.2	5.0	5.4	.848	.998	.998
L-16	.055	.019	.065	5.3	7.3	5.3	1.000	.836	1.000

n	15	13	10
$\bar{k}_{10}$ (day^{-1})	.043	.039	.043
s_{10}	.020	.017	.021

$\bar{k}_e$ (day^{-1})	.041
s_e	.019

Overall
n = 38
k_e = .094

* Excluded from calculation of average k.

** Values excluding day 6 data due to lag phase (see Table V-C-4 for r values based on all data).

COMPILATION OF CBOD and NOD
SEEDED EFFLUENT SAMPLE KINETICS

Table # V-C-9

Station	CBOD k_{10} (day^{-1})		CBOD L_o (mg/l)		CBOD (coefficient of correlation)	
	10/5	10/6	10/5	10/6	10/5	10/6
BS-005	.035	.043	4.8	5.7	.983	.985
BS-006	.073	.046	4.1	4.6	.951	.982
BS-007	.041	.046	3.5	4.7	.981	.981
BS-008	.040	.052	4.0	6.0	.989	.988
BS-010	.016	.045	5.2	5.4	.796	.981
BS-012	.021	.038	4.6	5.7	.981	.980
BS-014	.025	.043	5.3	5.8	.990	.976

	NOD k_{10} (day^{-1})		NOD L_o (mg/l)		NOD (coefficient of correlation)	
BS-005	.045	.043	5.7	1.1	.797	.996
BS-006	.032	.060	2.6	1.1	.993	.989
BS-007	.039	.018	2.2	3.5	.987	.877
BS-008	.035	.010	2.0	2.3	.981	-.485
BS-010	.024	.003	2.9	10.7	.999	.195
BS-012	.015	.015	4.5	4.5	.999	.768
BS-014	.043	.057	6.7	1.8	.996	.990

TABLE V - D-1

LEHIGH RIVER STUDY

DIURNAL DATA

Station	Date	Time	Location	pH (SU)	Temp. (°C)	D.O. (ppm)	Chlorophyll a (ppb)
L-1	10/5	0825	Right	6.85	12	10.6	----
			Center	7.1	12	10.6	----
			Left	7.2	12	10.6	----
			Avg./Comp.	7.05	12	10.6	4.5
L-1	10/5	1310	Right	7.5	13.5	10.8	----
			Center	7.45	13.0	10.7	----
			Left	7.45	13	10.5	----
			Avg./Comp.	7.43	13.16	10.6	0
L-1	10/5	2000	Right	7.55	14.1	10.5	----
			Center	7.55	14.0	10.6	----
			Left	7.5	13.8	10.4	----
			Avg./Comp.	7.53	14.0	10.5	3.0
L-1	10/5	2300	Right	7.3	14.0	10.6	----
			Center	7.2	14.0	10.4	----
			Left	6.5	14.0	10.3	----
			Avg./Comp.	7.0	14.0	10.4	4.5
L-1	10/6	0300	Right	7.6	14.0	11.1	----
			Center	7.65	13.6	10.9	----
			Left	7.65	13.3	10.5	----
			Avg./Comp.	7.63	14.6	10.8	4.5
L-4	10/5	0910	Right	7.2	12.2	10.6	----
			Center	7.2	12	10.2	----
			Left	7.2	12.2	9.8	----
			Avg./Comp.	7.2	12.13	10.2	0
L-4	10/5	1355	Right	7.3	14	10.4	----
			Center	7.4	14	10.2	----
			Left	7.3	14	10.1	----
			Avg./Comp.	7.33	14	10.23	0
L-4	10/5	1820	Right	7.25	13.5	10.5	----
			Center	7.1	13.5	10.5	----
			Left	6.6	14.5	10.4	----
			Avg./Comp.	7.0	13.8	10.4	----
L-4	10/5	2030	Right	7.5	14	10.0	----
			Center	7.5	14	10.0	----
			Left	7.4	14	10.8	----
			Avg./Comp.	7.5	14	10.3	4.5
L-4	10/6	0345	Right	7.6	13.8	10.2	----
			Center	7.5	14.0	9.8	----
			Left	7.5	14.0	9.5	----
			Avg./Comp.	7.53	13.9	9.8	3.0

TABLE V - D-1

LEHIGH RIVER STUDY

DIURNAL DATA

Station	Date	Time	Location	pH (SU)	Temp. (°C)	D.O. (ppm)	Chlorophyll a (ppb)
L-9	10/5	0935	Right	7.2	13.5	9.8	----
			Center	7.15	13	9.8	----
			Left	7.3	14	9.4	----
			Avg./Comp.	7.21	12.73	9.66	1.50
L-9	10/5	1420	Right	7.4	15	10.0	----
			Center	7.5	14.5	10.0	----
			Left	7.5	15.5	9.8	----
			Avg./Comp.	7.46	15.0	9.93	1.50
L-9	10/5	1900	Right	7.5	14.5	10.4	----
			Center	7.5	15	10.2	----
			Left	7.5	15.5	9.8	----
			Avg./Comp.	7.5	15.	10.1	3.0
L-9	10/5	2110	Right	7.5	14.5	9.8	----
			Center	7.5	14.9	9.5	----
			Left	7.55	15.5	10.1	----
			Avg./Comp.	7.53	15.0	9.8	6.0
L-9	10/6	0005	Right	7.45	14.5	9.7	----
			Center	7.5	15.0	9.3	----
			Left	7.35	15.5	9.0	----
			Avg./Comp.	7.40	15.0	9.33	7.5
L-9	10/6	0410	Right	7.3	13.8	9.7	----
			Center	7.55	14.2	9.3	----
			Left	7.5	14.5	9.0	----
			Avg./Comp.	7.45	14.1	9.33	3.8
L-11	10/5	1150	Right	7.25	15.0	9.5	----
			Center	7.3	14.0	9.3	----
			Left	7.3	14.0	9.0	----
			Avg./Comp.	7.28	14.3	9.26	1.50
L-11	10/5	1450	Right	7.3	14.5	9.3	----
			Center	7.35	14.5	9.3	----
			Left	7.4	14.5	9.0	----
			Avg./Comp.	7.35	14.5	9.2	1.50
L-11	10/5	1900	Right	7.3	16.0	9.8	----
			Center	7.3	16.0	9.8	----
			Left	7.3	16.0	9.4	----
			Avg./Comp.	7.3	16.0	9.7	4.5
L-1	10/5	2140	Right	6.8	15.0	9.8	----
			Center	6.6	15.0	9.7	----
			Left	6.7	15.0	9.6	----
			Avg./Comp.	6.7	15.0	9.7	7.5
L-11	10/6	0050	Right	7.35	14.5	9.4	----
			Center	7.4	14.5	9.5	----
			Left	7.45	14.5	9.4	----
			Avg./Comp.	7.40	14.5	9.0	3.0

TABLE V - D-1

LEHIGH RIVER STUDY

DIURNAL DATA

Station	Date	Time	Location	pH (SU)	Temp. (°C)	D.O. (ppm)	Chlorophyll a (ppb)
L-11	10/6	0440	Right	7.35	14.5	9.0	----
			Center	7.35	14.5	8.9	----
			Left	7.35	14.5	8.8	----
			Avg./Comp.	7.35	14.5	8.9	3.0
L-13	10/5	1010	Right	7.35	13.8	8.8	----
			Center	7.3	14	8.6	----
			Left	7.3	14	8.65	----
			Avg./Comp.	7.3	13.9	8.68	6.0
L-13	10/5	1520	Right	7.15	14.5	8.4	----
			Center	6.85	14.5	8.6	----
			Left	7.25	14.5	8.9	----
			Avg./Comp.	7.08	14.5	8.6	4.5
L-13	10/5	1950	Right	6.5	15.5	9.2	----
			Center	6.6	15.0	9.2	----
			Left	6.7	15.0	9.4	----
			Avg./Comp.	6.6	15.2	9.33	3.0
L-13	10/5	2100	Right	6.5	15.0	9.2	----
			Center	6.6	15.0	9.2	----
			Left	6.7	15.0	9.4	----
			Avg./Comp.	6.6	15.0	9.33	3.0
L-13	10/6	0125	Right	7.55	14.2	9.6	----
			Center	7.55	14.7	9.6	----
			Left	7.6	14.5	9.5	----
			Avg./Comp.	7.56	14.3	9.56	6.0
L-13	10/6	0515	Right	7.5	14.5	8.9	----
			Center	7.5	14.6	8.7	----
			Left	7.5	14.7	8.7	----
			Avg./Comp.	7.5	14.6	8.76	3.0

TABLE V - E-1

LEHIGH RIVER STUDY

MAJOR DISCHARGE FLOWS

Discharge Name	Flows		
	10/3 - 10/4 (MGD)	10/4 to 10/5 (MGD)	10/5 to 10/6 (MGD)
Allentown STP	30.0	34.2	29.2
Bethlehem STP	10.0	8.7	7.8
Bethlehem Steel Outfall #005	43.7	43.7	43.7
Bethlehem Steel Outfall #006	12.6	12.6	12.6
Bethlehem Steel Outfall #007	2.0	2.0	2.0
Bethlehem Steel Outfall #008	15.8	15.8	15.8
Bethlehem Steel Outfall #010	6.1	6.1	6.1
Bethlehem Steel Outfall #012	25.0	25.0	25.0
Bethlehem Steel Outfall #014	5.5	5.5	5.5
Bethlehem Steel Outfall #015	6.0	6.0	6.0
Bethlehem Steel Outfall #031	0.06	0.06	0.06
New Jersey Zinc (Saucon Creek below discharge)	38	38	38
Saucon Creek above discharges	.56	.5	.5

TABLE V E-2

LEHIGH RIVER STUDY

STREAM FLOWS

Station	Flows	
	10/4 (CFS)	10/6 (CFS)
Jordan Creek	142	104
Little Lehigh	60	57
Monocacy Creek	47	39
Saucon Creek	~60	~60
Lehigh River (hill to hill)	1905	1538
Lehigh River (Glendon)	2098	1648

TABLE V F-1

LEHIGH RIVER STUDY

TIME OF TRAVEL

Location	Date	Peak Time	Elapsed Time (hours)	River Mile	Average Speed Between Stations (MPH)	Comments
Hamilton Street Bridge, Allentown, PA	10/5/77	0300	--	17.3		1 qt. Rhodamine B dumped at 0300
					0.94	
0.15 miles downstream from Hill to Hill Bridge	10/5/77	0805	5.08	12.55		
					1.35	
Upstream from Saucon Creek 0.2 miles from Freemansburg Bridge	10/5/77	1025	7.42	9.4		
					0.59	
Downstream from Pipeline near Redington	10/5/77	1609	13.15	6.0		

STREAM FLOWS

Location	Approximate Flow*
Lehigh at Bethlehem (Hill to Hill Bridge)	1720 CFS
Lehigh at Glendon	1875 CFS

* Flows were measured on 10/4 and 10/6. The approximate flow is the average of these flows shown in Table V - E-2.

Done By: Gerard R. Donovan, Jr.
Ronald Jones

TABLE V - F-2

LEHIGH RIVER STUDY

TIME OF TRAVEL (1976)

Location	Date	Peak Time	Elapsed Time (hours)	River Mile	Average Speed Between Stations (MPH)	Comments
Hamilton Street Bridge, Allentown PA	10/6/76	0440	--	17.3	---	Dye Dump ~ 2000 ml Rhodamine B at 0440
					1.28	
15 miles downstream from Hill to Hill Bridge	10/6/76	0823	3.72	12.55	---	
					1.85	
Just upstream from mouth of Saucon Creek.	10/6/76	1005	5.42	9.4		

FLOW MEASUREMENTS

Location	Gauge Ht. (feet)	Flow (CFS)	Time	Comments
Hamilton Street Bridge, Allentown, PA	--	--	--	Gauge key would not work in lock.
Lehigh at Bethlehem (01453000)	2.70	2860	0800	
Lehigh at Glendon (01454700)	8.5	2730	1115	

Done By: George H. Houghton
William M. Thomas, Jr.
Robert L. Vallandingham
Ronald Jones

G. Benthic Characterization-Sediment Oxygen Demand

At station L-13 the bottom was hard and sandy in the middle and on the right side (looking upstream). Near the shore on the right side the bottom was a black, granular material, possibly coal dust, and the respirometer was able to seat properly. The D.O. inside the respirometer dropped 2.0 mg/l in 80 minutes during the test. There was no change in the accompanying dark bottle D.O., therefore it is assumed that all of the D.O. change is related to benthic demand. Following are the calculations for SOD at L-13.

$S' = 2.0 \text{ mg/l} \div 80 \text{ minutes} = .025 \text{ mg/l/min}$

$S'' = 0$

$S = .025 \text{ mg/l/min}$

$SOD = 107 \times S$

$SOD_{14.5^{\circ}C} = 107 \times .025 \text{ mg/l/min} = 2.675 \text{ g/m}^2\text{/day}$

$SOD_{20^{\circ}C} = SOD_{14.5} \times \Theta^{(20 - T)}$

$= 2.675 \times 1.06^{(20 - 14.5)} = 2.675 \times 1.414 = \underline{3.78} \text{ g/m}^2\text{/day}$

LEHIGH RIVER STUDY
SEDIMENT OXYGEN DEMAND

FIGURE V-G-1

by
GERRY DONOVAN &
RON JONES

STATION: L-13

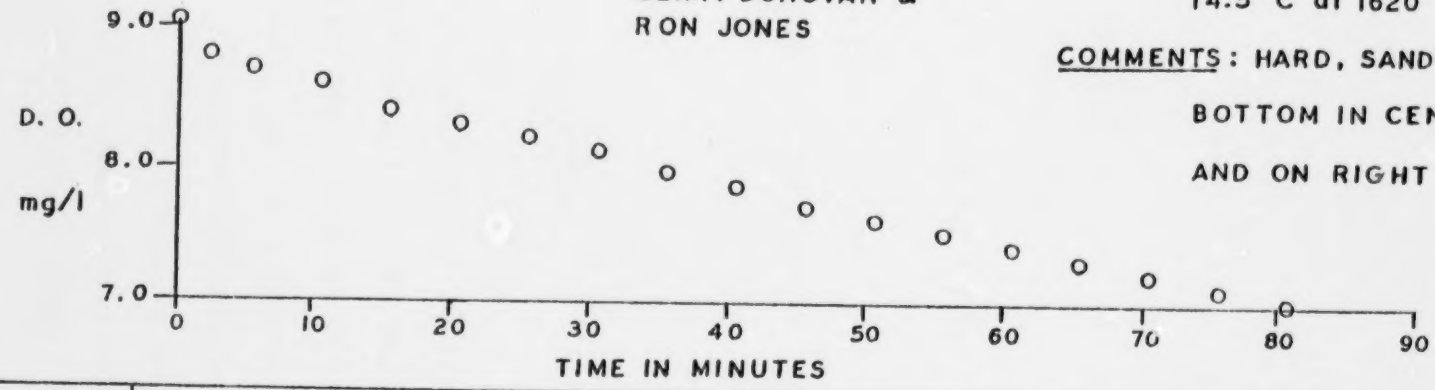
DATE: 10-4-77

STATION DESCRIPTION:
LEFT SIDE LEHIGH,
10' FROM LAND

WATER DEPTH: 10'

BOTTOM TEMPERATURE:
14.5° C at 1620

COMMENTS: HARD, SANDY
BOTTOM IN CENTER
AND ON RIGHT



TIME:	1500	1502	1505	1510	1515	1520	1525	1530	1535	1540	1545	1550	1555	1600	1605	1610	1615	1620
ELAPSED TIME:	0	2	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
D.O.:	9.0	8.8	8.7	8.6	8.4	8.3	8.2	8.1	8.0	7.8	7.7	7.6	7.5	7.4	7.3	7.2	7.1	7.0

TABLE V - G

LEHIGH RIVER STUDY

BENTHIC CHARACTERIZATION

	% dry weight			mg/kg					
	TKN	TP	TOC	Zn	Cr	Cd	Cu	Pb	Fe
L-13 Lehigh Upstream of Glencom Dam	.838	.1881	1.73	807	17.1	10.9	55.2	95.6	6780
L-16 Lehigh at 3rd Street Bridge	.421	.1258	1.68	697	10.8	6.4	48.0	71.8	8525

VI. Conclusions

A. A review of the long-term BOD data revealed a general trend of decreasing TKN-N concentration correlated with increasing (NO_2+NO_3)-N concentration, associated with the processes of nitrification. The one exception to this pattern was Bethlehem Steel outfall 031. This outfall had a high average BOD 29/31 of 763 ppm and a high average initial TKN-N of 359 ppm. However, little or no (NO_2+NO_3)-N was formed after 30 days of incubation. The sample was analyzed for phenol & cyanide and found to contain 35.9 ppm total phenol and 50 ppm cyanide. This suggested that the outfall was toxic to nitrifying bacteria but not to the heterotrophic species present.

B. Nitrite was formed with incubation, but except for 771006-15 and 16 it decreased to "not detectable" (ND) after 30 days of incubation.

C. A paired t-test of the results of the calculated NOD and TCMP NOD over the combined 218 paired data sets established at the 95% confidence level ($t = 0.75$) that there was no significant difference in the results of the two NOD methods.

D. The average river CBOD and NOD rate constants k_e were respectively 0.090 ($n = 41$) and 0.094 ($n = 38$).

E. The carbonaceous demand followed first order kinetics in the river samples. The river NOD involved at least a six day lag phase, in which the nitrifying bacteria present may have become acclimated to the experimental conditions and/or increased in number enough to make a significant contribution. The river NOD rate

calculations are included in Table V-C-4. The deoxygenation constants and ultimate NOD were calculated using "all points" and recalculated excluding the early lag phase. This lag phase was assumed to be a laboratory artifact and the deoxygenation constants compiled (Table V-C-8) were based on the last three data sets.

F. The effluent samples which were both seeded and diluted often depleted oxygen (CBOD) in a linear pattern with time, which resulted in poor correlation coefficients to first-order kinetics. The NOD for these samples displayed a lag time similar to the river samples (Table V-C-5 and V-C-6) and the k_e values reported were similarly based on the last three data sets.

APPENDIX A

A problem with the TKN analysis was encountered with several samples. These results were considered questionable and appear as L.A. (laboratory accident) in the data summary table. The results for these samples were as follows:

Date	Station	Days of Incubation	TKN-N (ppm)
10/5	Bethlehem 015	6	55.5
10/5	Bethlehem 015	29	65.8
10/5	Bethlehem 031	29	59.6
10/6	T-6	Original Sample	3.4
10/6	Allentown STP	0	4.7
10/6	Bethlehem 015	6	81.3
10/6	Bethlehem 001	6	7.56

It is unclear whether the problem was due to interferences present in the sample or due to the imprecision in the TKN-N test amplified by the dilutions involved.

APPENDIX B

EPA PRECISION AND ACCURACY

Parameter	Conc. Range	Accuracy (avg. % bias)	Conc. Range	Precision-Standard Deviation of the Difference
Dissolved Oxygen				
Electrode	0 - 20 ppm	± 1%	0 - 20 ppm	0.1 ppm
Winkler	--	--	7.5 ppm	∿.2 ppm
Chlorophyll a	--	--	--	--
Total Kjeldahl Nitrogen	1.89 ppm	-24.6%	1.89 ppm	0.54 ppm
	2.18 ppm	-28.3%	2.18 ppm	0.61 ppm
	5.09 ppm	-23.8%	5.09 ppm	1.25 ppm
	5.81 ppm	21.9%	5.81 ppm	1.85 ppm
Ammonia	.16 ppm	+7%	0.43 ppm	±.005 ppm
	1.44 ppm	-1%	1.41 ppm	±.005 ppm
Nitrite plus Nitrate	0.29 ppm	+5.75%	0.29 ppm	0.012 ppm
	0.35 ppm	+18.10%	0.35 ppm	0.092 ppm
	2.31 ppm	+4.47%	2.31 ppm	0.318 ppm
	2.48 ppm	-2.69%	2.48 ppm	0.176 ppm
Phenolics	--	--	9.6 ppb	±0.99 ppb
	--	--	48.3 ppb	±3.1 ppb
	--	--	93.5 ppb	±4.2 ppb
	--	--	4.7 ppb	±0.18 ppb
	--	--	48.2 ppb	±0.48 ppb
	--	--	97.0 ppb	±1.58 ppb
BOD_5	--	--	2.1 ppm	±.7 ppm
	--	--	175 ppm	±26 ppm
METALS				
Zn	281 ppb	1.2%	281 ppb	97 ppb
	310 ppb	-.7%	310 ppb	114 ppb
	56 ppb	11.3%	56 ppb	28 ppb
	70 ppb	6.6%	80 ppb	28 ppb
	7 ppb	206%	7 ppb	28 ppb
	11 ppb	56.6%	11 ppb	18 ppb

APPENDIX B

EPA PRECISION AND ACCURACY

Parameter	Conc. Range	Accuracy (avg. % bias)	Conc. Range	Precision Standard Deviation of the Differe
Mn	426 ppb	1.5%	426 ppb	70 ppb
	469 ppb	1.2%	469 ppb	97 ppb
	84 ppb	2.1%	84 ppb	26 ppb
	106 ppb	-2.1%	106 ppb	31 ppb
	11 ppb	93%	11 ppb	27 ppb
	17 ppb	22%	17 ppb	20 ppb
Fe	840 ppb	1.8%	840 ppb	173 ppb
	700 ppb	-2.8%	700 ppb	178 ppb
	350 ppb	-0.5%	350 ppb	131 ppb
	438 ppb	-0.7%	438 ppb	183 ppb
	24 ppb	141%	24 ppb	69 ppb
	10 ppb	382%	10 ppb	69 ppb
Pb	367 ppb	2.9%	367 ppb	128 ppb
	334 ppb	1.8%	334 ppb	111 ppb
	101 ppb	-0.2%	101 ppb	46 ppb
	84 ppb	1.1%	84 ppb	40 ppb
	37 ppb	9.6%	37 ppb	25 ppb
	25 ppb	25.7%	25 ppb	22 ppb

APPENDIX B (con't)

Parameter	Conc. Range	Accuracy (ave. % bias)	Conc. Range	Precision std. deviation of the diff.
Cd	71 ppb	- 2.2 %	71 ppb	21 ppb
	78 ppb	- 5.7 %	78 ppb	18 ppb
	14 ppb	19.8 %	14 ppb	11 ppb
	18 ppb	1.9 %	18 ppb	10.3 ppb
	1.4 ppb	13.5 %	1.4 ppb	5.0 ppb
	2.8 ppb	4.7 %	2.8 ppb	2.8 ppb
Cu	302 ppb	0.9 %	320 ppb	56 ppb
	332 ppb	- 2.4 %	332 ppb	56 ppb
	60 ppb	7.0 %	60 ppb	23 ppb
	75 ppb	1.3 %	75 ppb	22 ppb
	7.5 ppb	29.7 %	7.5 ppb	6.1 ppb
	12.0 ppb	15.5 %	12.0 ppb	9.7 ppb
Cr	370 ppb	- 4.5 %	370 ppb	105 ppb
	407 ppb	- 6.5 %	407 ppb	128 ppb
	74 ppb	- 3.1 %	74 ppb	29 ppb
	93 ppb	-10.2 %	93 ppb	35 ppb
	7.4 ppb	37.7 %	7.4 ppb	7.8 ppb
	15 ppb	6.8 %	15 ppb	9.0 ppb
Total Phosphorus (T-PO4)	0.07ppm	- 1.0 %	.04ppm	± .005 ppm
	0.76ppm	0 %	.19ppm	± .000 ppm
			.35ppm	± .003 ppm
			.84ppm	± .000 ppm
Total Organic Carbon (TOC)	4.9 ppm	+15.32 %	4.9 ppm	3.93 ppm
	107 ppm	+ 1.01 %	107 ppm	8.32 ppm

APPENDIX C

Benthic Respirometer

The AFO benthic respirometer is shaped like a pyramid with vertical and horizontal stabilizing flanges. A DO probe is fixed in one side wall of the pyramid and a small pump is attached on the wall with the pump discharge opposite the DO probe membrane. Circulation from the pump discharge provides the mixing required when using the probe method of DO measurement. The inside volume was measured to be 27.62 l and it covers a surface area of 4 ft^2. (See Figure III-1). Plotting the DO concentration inside the respirometer against time typically results in a constant negative slope for the first 30 to 60 minutes; after this initial period, the slope gradually approaches zero (see Figure III-2). The initial slope, S' (mg/l/min), is taken as the net respiration in the sediments and trapped water. If a dark bottle filled with bottom water is placed next to the respirometer during operation, the DO concentration will decline due to aerobic respiration in the trapped water. Subtracting the average respiration rate in the water column, S" (mg/l/min), from the initial slope measured by the respirometer will give the respiration in the sediments:

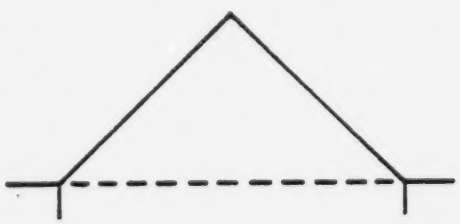
$$S\ (mg/l/min) = S' - S" \qquad (1)$$

This measure of benthic respiration must be converted to standard units as follows:

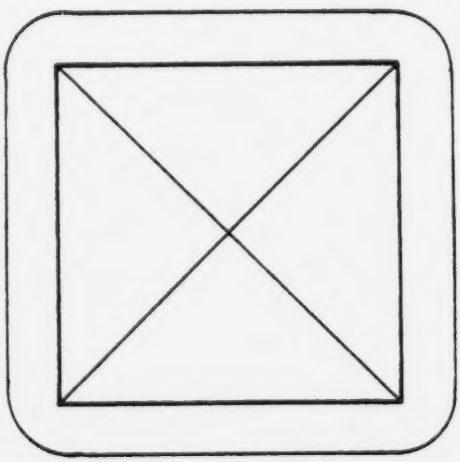
$$SOD_T\ (g\ DO/m^2/day) = S\ (mg/l/min) \times 1440\ (min/day) \times 0.001\ (g/mg) \times 10.764\ (ft^2/m^2) \times V\ (l) \times A^{-1}\ (ft^2) = 0.258 \times S \times V/A \qquad (2)$$

Figure C-1

BENTHIC RESPIROMETER



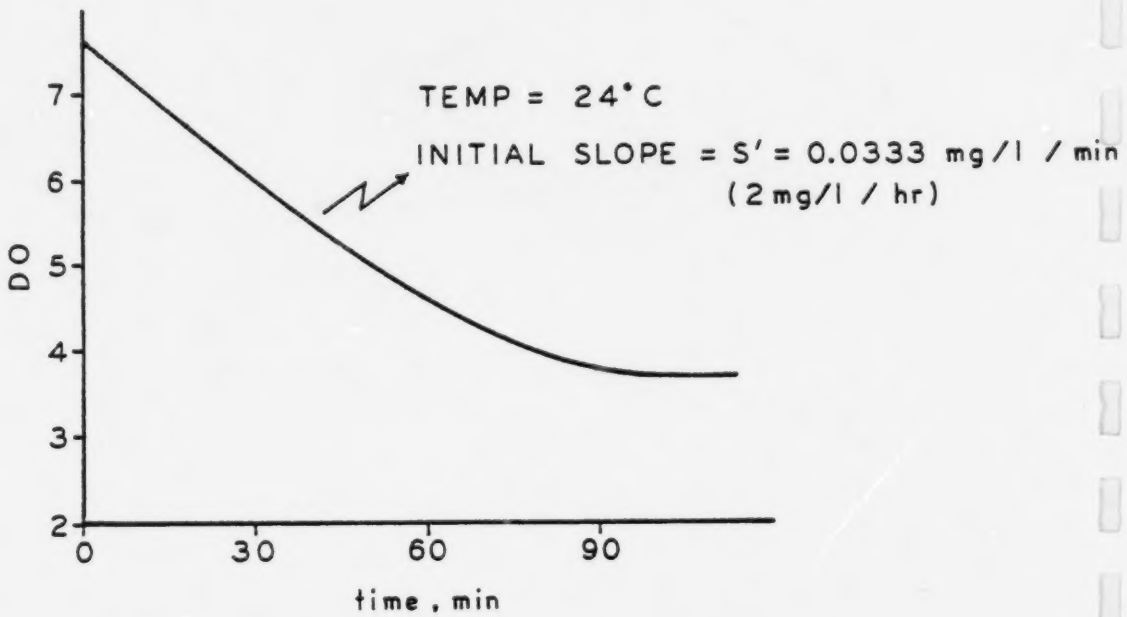
V = 27.6 l



A = 4 ft²

Figure C-2

TYPICAL GRAPH AND WORKSHEET FROM RESPIROMETER



DARK BOTTLE DROPS 0.2 mg/l IN 60 MINUTES

$S'' = 0.0033$ mg/l / min

$S = S' - S'' = 0.030$ mg/l / min

$SOD_T = 107 \times S = 3.21$ g/m^2/day

$SOD_{20} = SOD_T \times 1.065^{20-24} = 2.50$ g/m^2/day

Given the volume and bottom surface area of our particular benthic respirometer, equation (2) becomes:

$$SOD_T \text{ (g DO/m}^2\text{/day)} = 107 \times S \text{ (mg/l/min)} \quad (3)$$

Aerobic bacterial respiration is generally considered to be an exponential function of temperature such as:

$$R_{20} = R_T \times \Theta^{T-20} \quad (4)$$

where R_{20} = rate at 20^oC;

R_T = rate at T^oC;

Θ = temperature correction factor (1.05 - 1.10, generally)

Our SOD data, measured at T^o, is finally reported as corrected to 20^o with Θ set at the standard value of 1.065:

$$SOD_{20} = SOD_T \times 1.065^{(20-T)} \quad (5)$$

REFERENCES

1. EPA Methods for Chemical Analysis of Water and Wastes, 1974.

2. Finstein, M.S., et al, "Distribution of Autotrophic Nitrifying Bacteria in a Polluted Stream", N.J. Water Resource Research Institute W7406834, February 1974.

3. Wezernak, C.T. and Gannon, J.J., "Evaluation of Nitrification in Streams", J. Sanitary Engineering Division; Program of American Society of Civil Engineers, p. 883 - 895 (Oct. 1968).

4. Thomas, H.A., "Graphical Determination of B.O.D. Curve Constants", Water and Sewage Works, p. 123 - 124, March 1950.